Measuring the impacts of hospital nursing floor and patient room layouts on patients' experience with care in a major teaching hospital

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Measuring the impacts of hospital nursing floor and patient room layouts on patients' experience with care in a major teaching hospital

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Over six years ago, I had the privilege of meeting Craig Zimring when we were both invited to participate in a visioning session discussing the future of healthcare architecture. It was that opportunity that encouraged me to further explore my ideas and concepts of how buildings impact us as human beings. My exploration has been guided by influential people that lent me their ears and opened many doors for me. I am so very grateful to each one of them.

I started my journey as a medical social worker and quickly learned that the environments in which I chose to have sensitive conversations could impact the patient and their family members. I began to reposition the rooms and subsequently received better results. Looking back, that was my first study. An insightful mentor, Sister Aline Millard, opened my eyes to my skills and opened the door for me to explore the world of design through the lens of a social worker. This was my quest to seek out the answers to how the environment can support the occupants and their relationships. I continued to learn and explore as I received a M.Arch degree and became a licensed architect, always with a focus on acute inpatient hospital design. Continuing to explore the impact of the environment, I worked with Janet Brown at Practice Green Health to establish the operational guidelines for the Green Guide for Healthcare. This work opened my eyes even further to the impact of the built environment. All throughout this time, I was still looking for the research that began to weave it all together.

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Summary

As the ever evolving landscape of the healthcare industry shifts from a focus on volume to one on value, there has developed heightened awareness of the importance of the patient's experience of care. The industry will no longer be paid based on how many procedures are completed, or the number or people the hospital has seen, but on the quality of care delivered. This means that the patient's own reported outcomes will play a significant role in the evaluation of quality care. This transformation is historical as it allows for the entire industry to reexamine the science of how care is delivered and how quality outcomes are measured. At a human interaction level, (Harris, McBride, Ross, & Curtis, 2002a) healthcare delivery happens at the interface of the patient and the practitioner during the care experience. At a tactical level, it is the interaction of the patient's presented symptoms and the practitioner's treatment regimen. This study focuses on the human interaction level of engagement and the tools both the patient and practitioner have all around them in the built environment. In many instances practitioners are unaware of the impact of the built environment on the delivery of quality care.

There is a growing body of literature that suggests that the architectural features (Harris et al., 2002a) of an inpatient room and unit layouts do, in fact, impact a range of occupant outcomes such as stress (Blomkvist, Eriksen, Theorell, Ulrich, & Rasmanis, 2005; Hagerman et al., 2005; Harris, McBride, Ross, & Curtis, 2002b), falls, and mortality (Leaf, Homel, & Factor, 2010; Y. Lu, Ossmann, Leaf, & Factor, 2014). The health outcomes of falls and mortality have long been leading indicators of health care quality. Quantifying health care quality has become a hot topic in the past decade and, more recently, with the adoption of the Affordable Care Act in the United States on March 23, 2010. in 1995, the National Committee for Quality Assurance developed the Consumer Assessment of Healthcare Providers and Systems program (CAHPS)(Goldstein, Farquhar, Crofton, Darby, & Garfinkel, 2005b). This program provided tools to evaluate healthcare quality equally at every hospital in the nation, for the purpose of improving the quality of care at key points in the healthcare delivery process. It has also provided visibility

to the patient experience and empowered patients to view the performance of their hospital through the Hospital Compare website (hospitalcompare.gov). All of these developments have provided a new key indicator of healthcare quality through the *experience* of care – which goes far beyond patient falls and injuries and has more significance than just pleasing a patient through amenities and ambiance.

The research on how architectural features impact the patient experience of care has focused primarily on aesthetics (Siddiqui, Zuccarelli, Durkin, Wu, & Brotman, 2014; Swan, Richardson, & Hutton, 2003) and the influence of home-like environments on the patient (Martin, Hunt, & Conrad, 1990).

This study intends to build a more clear relationship between the architectural features (spatial variables) of a large teaching hospital unit and patient room layout and patient experience of care. This study aims to move beyond the aesthetic qualities of the spaces (Siddiqui et al., 2014; Swan et al., 2003) to study the functional relationships that enhance the ability of users to more deeply engage with the space and to provide experiences with a positive outcome. This study explores 19 inpatient unit layout characteristics as the independent variable with the dependent variables of self-reported outcome measures provided by Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) and Press-Ganey surveys collected over two and five years at a large academic teaching hospital to demonstrate the plausible relationship. Therefore, this study makes the plausible linkage that the physical room layout and environment can impact the quality of care beyond the aesthetic components.

1. Introduction

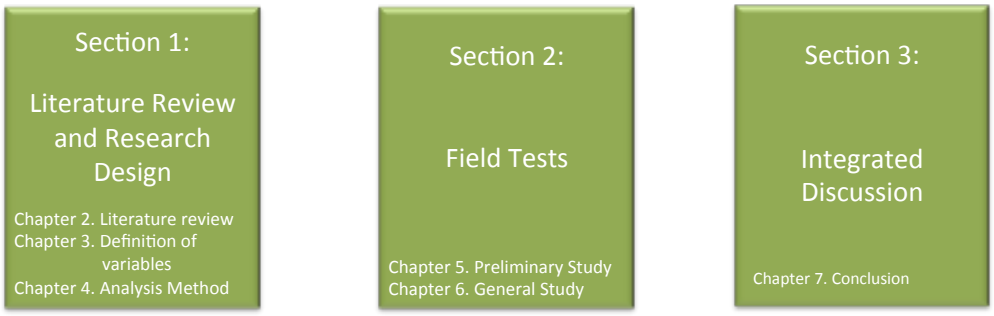
1.1. Summary

The definition of high quality healthcare is meeting both the subjective and objective experience of wellness in the hospital visit (M. H. Hill & Doddato, 2002). The subjective experience of wellness is the individual perception of the patient collected through the patient self-reported outcome survey and the objective experience of wellness is the patient's actual health outcome or symptom reduction. It is the intent of all healthcare systems to deliver high quality care. The emphasis of delivering high quality healthcare has long been focused on the operational aspect of care delivery. While this operational component is important, it is the belief of this author that the ability to deliver care - and the patient's perceived experience of that care, e.g., patient satisfaction - is strongly influenced by the built environment. There is a growing body of literature which suggests that the layout of inpatient hospitals impacts a range of outcomes such as noise, falls, and mortality (Choi, 2011; Choi, Lawler, Boenecke, Ponatoski, & Zimring, 2011; Leaf et al., 2010; Y. Lu et al., 2014). However, the research has not yet addressed how layout impacts the patient's experience of care. Experience of care is of growing importance to hospitals because of their commitment to patients, because it is increasingly linked to payment, and it is reported publically.

This study bridges this experience gap by exploring the relationship between layout of the inpatient room and patient self-reported outcome scores in the United States. This retrospective study examines 17 units over two to five years at a large teaching hospital, using spatial measures to analyze layouts, and explores the association with patient self-reported outcome measures using both HCAHPS and Press-Ganey surveys. This study further investigates how layouts can be measured and how room layout might impact the engagement of caregivers as they enter the patient room. This author intends to demonstrate that there is a correlation between patient self-reported outcome scores and the positioning of the patient room.

The complexity of establishing correlation between built environment and human behavior, or perceived behavior, has long been a challenge for the field of architecture. The ability to isolate all the moderating variables that are possible influencers – to pin-point one direct cause – is a challenge. In this study, while the overall intent is to demonstrate a plausible relationship between the room and unit layout and the perceived quality of care received as reflected in patient self reported outcome, the study is also methodological – systematic tests were used to explore potential moderators of the environment/satisfaction relationship. Therefore, this dissertation is broken into three sections (Figure 1.1) with three phases of analysis (Figure 1.2). The first section, *Establish Methodology*, includes a detailed literature review of the predictor variable - the spatial variable. The work conducted in Chapter Two is intended to build on previous research in the field; research that has established influential components of the environment that plausibly relate to patient outcomes. Additionally, in Chapter Two, moderators are established through a more limited review of the identified moderators of the study that could impact the patient's experience of care. The goal of this chapter is to show association of both patient characteristics and spatial variables in the inpatient room and inpatient nursing unit that could impact either clinical outcomes or patient reported outcomes.

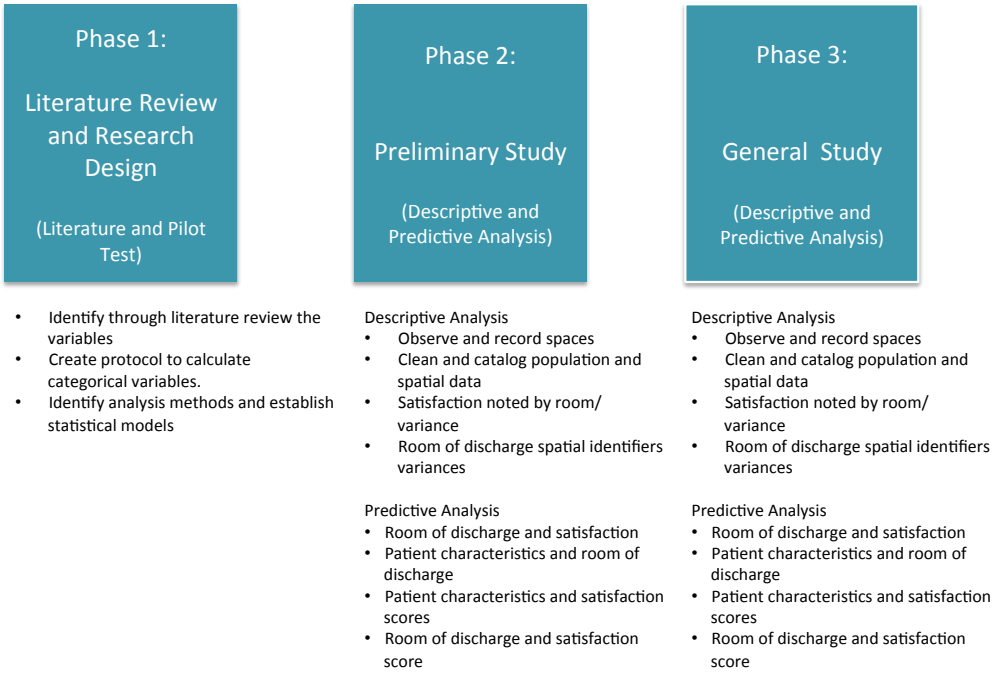
Figure 1-1 Sections of the research study with description of the contents in each section



It is to be noted that this study is ambitious in its attempt to control or identify all of the possible association of the patient's experience of care. In this study, the setting selection will attempt to control all other possible moderating variables to a reasonable extent. Chapter Four

establishes the detailed series of research questions that are explored in the study and the related statistical tests that demonstrate their association. These questions and statistical tests create an established protocol for the research and are intended to tease out any other outliers of association in a very complex system. It is difficult to isolate all variables that could influence a person's experience of space, but this study aims to establish an agreed upon method that could be used for other studies in the future.

Figure 1-2 Phases of the research and the activities and analysis for each phase



The next section, *Field Tests,* includes the last two phases of analysis (Figure 1.2), where the established analytical method is used in two different settings. Chapter Five first looks at the preliminary population of a stable patient population, cardiology, over a five year period of time. All the tests were explored and reviewed to see if there is a possible relationship between spatial environment components and the patient's experience of care. The same statistical analysis methodology that was used for the preliminary test was used for the more general population field study in Chapter Six. The general field study in Chapter Six is a broader sample of the entire

campus not controlling for culture, which included 15 units over two years of time. This population excludes other campuses and less predictable populations, such as patients in clinical trials or the Intensive Care Unit (ICU). All patients were coded by the disease-related group they were given at discharge. The same methodical analysis was conducted for the general population and the outcomes were noted.

In Section Three, Chapter Seven reviews the findings from both field studies and explores the plausible relationships. This section discusses the success or shortcomings of the analysis methodology in its use for this dissertation or for further studies. It also identifies any limitations of this study and suggests further opportunities to continue this research in other settings.

1.2. Background- Research Problem

In the past decade, healthcare systems in the United States have been increasingly focused on operational efficiency to deliver healthcare with increased speed and improved safety and quality. More recently, with the development of the 1995 Consumer Assessment of Healthcare Providers and Systems program (CAHPS), the focus has shifted to the patients' experience of care delivery (Goldstein et al., 2005b). The CAHPS assessment tool was developed to glean an understanding of what occurred at critical points in the patient care process. The focus of CAHPS is not on amenities or the satisfaction of the patient. The CAHPS tool system was used to create a hospital-based survey known as Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS). This survey has been the foundation of what the Centers for Medicare and Medicaid Services (CMS.gov) use as the universal evaluation tool for the United States.

This program and tool provided a way to evaluate healthcare quality equally, at every hospital in the nation, for the purposes of improving the quality of care. It also has provided visibility into the patient experience and empowered patients to review the performance of their hospital through the Hospital Compare website. With the adoption of this program physicians

and, health systems are now being graded not only on care outcomes but also for their bedside manner (Padela, Schneider, He, Ali, & Richardson, 2010). This is the shift that is being felt in the industry that is directly linked to reimbursement. Healthcare providers are no longer being paid by the volume of patients that they see but by the quality or "value" of the care they have received.

The definition of high quality healthcare is meeting both the subjective and objective experience of wellness in the hospital visit (M. H. Hill & Doddato, 2002). It is the intent of all healthcare systems to deliver high quality care collectively meeting both the objective and subjective. There are velar measurements of the objective but the subjective has been lagging in a more fully understandable association. This study intends to quantify the subjective aspect of patient self-reported outcomes and more clearly evaluate components of space and patient satisfaction, with the focus on the nursing unit as one of the most influential settings.

Patient self-reported outcome scores, e.g., Press Ganey, can shed light on the difference between patient expectations for care delivery and the care that is actually received (Larrabee & Bolden, 2001). Aligning patient expectations with the actual care experience is the real work of hospital administrators attempting to improve patient self-reported outcome scores by identifying triggers that can change cognitive interpretations (i.e., expectations) of patients (Armstrong, 1991). The systematic collection of patient self-reported outcome data not only provides important information regarding the care experience, but also has been shown to be an indicator of whether the patient will follow treatment regimens (Weisman & Nathanson, 1985).

In a review of the literature on patient satisfaction, Sitzia and Wood (1997) identified several determinants of patient self-reported outcome including their characteristics, expectations, and psychosocial factors. Noticeably missing from the list was the potential impact of the physical environment on patient self-reported outcome.

The newly-emerged field of evidence-based design is further defining the role of the environment in influencing the occupant through measurable outcome variables (Ulrich et al., 2008). A number of studies have shown that there is a relationship between the physical

environment, such as views from windows, to patient self-reported outcome further discussed in Chapter Two (Davidson, 1994; Devlin & Arneill 2003; Lemprecht, 1996; Ulrich, 1984; Verderber & Reuman, 1987). While these are important findings, the studies do not address the contribution of nursing behavior in mediating the relationship between the physical environment and patient self-reported outcome.

Sherwood (Sherwood, 1997) concluded, through meta-analysis, that patient self-reported outcome had a direct relationship to nursing care. The notion that the behaviors of nurses could be associated, or compromised, by the environment has no been explored in previous research. Therefore, this exploratory study intends to investigate the implied relationship of the care giver that is supported by the physical environment and measured through patients' self-reported outcomes.

1.3. Research Goal

This research study goal is to explore the relationship of patient self-reported outcomes, (i.e., patient satisfaction) as associated by spatial layout through the execution of various statistical tests.

The field studies consist of two separate patient populations over varying time periods. Exploring two separate populations allows for a comprehensive exploration of all the variables of interest and their possible relationship with varying moderators. This first-of-its-kind study will demonstrate that there is a relationship between spatial layout and patient self-reported outcomes. Upon the completion of this study, future work could investigate further how the environment can possibly be a predictor of the outcome experienced by the patient.

1.3.1. Specific Aims

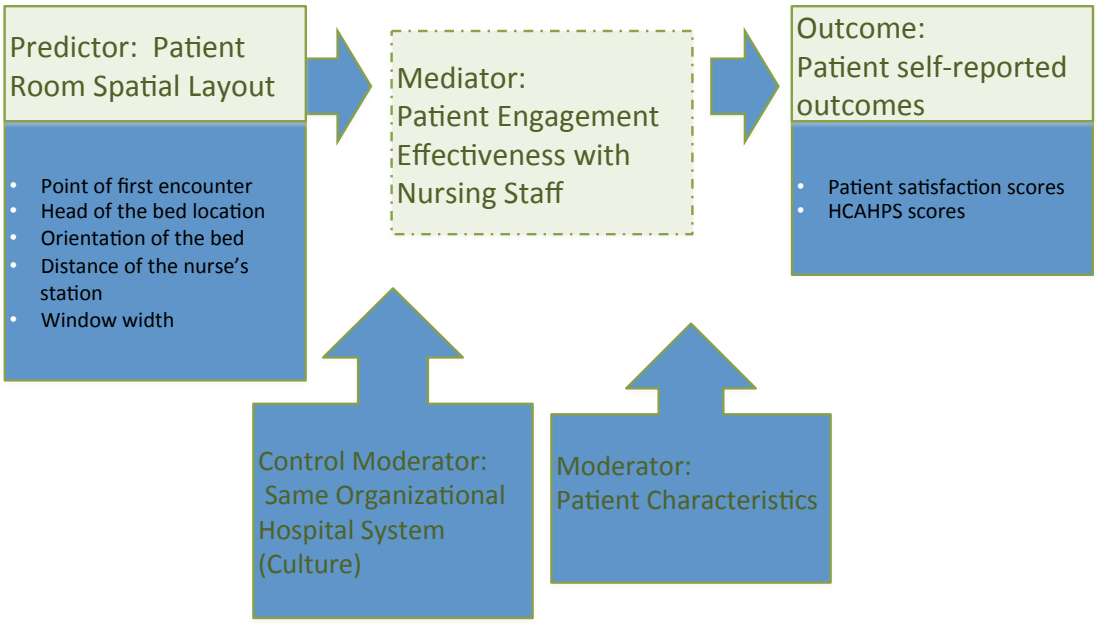
AIM 1: Identify the variables that have an association on patient self-reported outcomes based on previous research

1A: Catalog the identified patient characteristic variables and determine how they are measured.

2A: Catalog the identified spatial variables and determine how they are measured.

AIM 2: Analyze and explore the relationship of the acute inpatient room, unit spatial variables (defined later), and satisfaction outcomes

Figure 1-3 Overall causal model that represents the framework for this research study. This study examines the relationship of patient satisfaction and spatial layout. The mediators and moderated noted for study in future work.



1.4. Research model

As stated above, this study aims to test the noted causal model and to explore the relationship between spatial variables of inpatient room and unit, the patient reported outcomes from their experience in occupying that environment (Figure 1.3) using HCAHPS, and patient satisfaction scores. The predictor variable is the spatial layout, while the outcome variable is the

patient reported outcomes. In outcome variable of patient self-reported outcomes, each survey contained 43 individual questions. The initial study only looked at 18 questions, as it was initially testing the plausible relationship (MacAllister, 2014). The larger general field study included all of the questions. The five spatial layout variables, noted through research and evidence in the field, are defined by the author through observation on the unit.

The research model (see Figure 1.3) identifies the possible moderators that could influence the relationship of the two variables such as patient characteristics and organizational culture. This study will not measure the staff's level of engagement, or other cultural association, but will control them through careful selection of the study site. The isolation of culture was accomplished by the following known organizational culture components and their relationship to building environment:

1. The building that the staff work in is a organization of its own.. The building is managed by one hospital system.
2. The individual floor or specialty unit in that building has a team of people working together to serve the same patient population. defined by the admitted diagnosis defined as the Disease Related Group (DRG). The care delivered to these patients are similar and require staff to have similar skills.
3. The hospital is a 24 hour operating system which requires multiple shifts of staff to serve the population. The specific staff on the shift create their own culture.

All information gathered for this study is tied back to one hospital and one building on the campus of The Emory University Hospital (EUH). The next level of organizational culture is the unit. The 17 units in this study are on the same campus and vary by size, shape, and specialty. These units have various spatial layouts and different organizational cultures. The preliminary field study was conducted on two units that contained the same patient population as defined by their disease related group. The disease related group is the third level of cultural influence. The patient's diagnosis will shape the care plan for that patient and some diagnoses have more

predictable outcomes and experiences than others. In the preliminary population, this study identified a very stable care trajectory within cardiac care. Care protocols are fixed for this patient type and the possible influencers are minimized, though it should be noted that they are not eliminated. In summary, the culture of an organization can be influenced by many factors but, in this study, these influencers are intended to be controlled through the selection of the site. There is one hospital site, in one of the buildings, with two units in the preliminary study within a group of similarly defined patients through the DRG (MacAllister, 2014). The staffing and the shifts were noted as a possible influencer; however, the number of surveys per room was on average 40. This is high enough to control for the staffing variation.

The other moderating variable of the present study comes from the patients themselves. The field of patient satisfaction has identified specific characteristics of patients that are shown to influence patient outcomes. Three characteristics were identified in the previous study (MacAllister, 2014) and two additional characteristics were added in this study and will be described in Chapter Three.

The primary unit of measure for this study was patient responses to survey questions (MacAllister, 2014). A total of 8,366 surveys were examined in the two separate sample studies, preliminary (N=3,751) and general (N=4,615) study. Each survey had included various questions from both Press Gainy and HCAHPS. The preliminary population only included Press Gainey questions, as the number of returned surveys question answered were very low. The two samples were explored to see if there was a relationship between the scores of the surveys and the room where the patient was discharged. This allows for each survey to have defined spatial variables tied to the survey, just as it would have patient characteristic variables. Therefore this research model is framed to primarily explore the relationships of these defined variables. The variables are explained in greater detail in Chapter Three.

1.5. Research questions

The relationship between patient self-reported outcomes and the spatial variables in the hospital environment will be explored through a series of questions. There are nine exploratory research questions that move through understanding the population and their patient characteristics as determinants of satisfaction to further review of the possible relationships between spatial variables and satisfaction. The patient experience of care variables were coded to only look at the outcomes that were scored at 100%. This analysis and evaluation is referred to as Top Box scores in this study.

1. What are the sample population's characteristics?
2. Is there a relationship between room of discharge and satisfaction scores?
3. Do certain categories or locations of rooms explain better room performance? (number of top box scores on average in the room of discharge during the study period)? Is there a visual pattern of room performance?
4. Are the individual satisfaction questions related? Does each question follow the same result?
5. Are the patients assigned to rooms randomly? Is there a correlation between room type/number and patient characteristics?
6. Do patient characteristics completely explain satisfaction scores?
7. Do room categories and unit types have significantly different patient profiles or patient characteristics?
8. Are Differences in satisfaction scores explained by spatial characteristics of the room and unit?
9. What is categorical spatial variable performance? Explore the possible room type performance based on the findings from the analysis (number of top box scores in that room during the study period)?

1. What are the sample population's characteristics?

The first research question (1) identifies the sample population by patient characteristics. As an individual representative sample - who are the patients and how are the patients distributed by room and unit per their individual characteristics? What is the sample population by patient characteristics? Does each room have even distribution of patient types?

2. Is there a relationship between room of discharge and satisfaction scores?

The next research question (2) seeks to determine if there is a relationship between room of discharge and satisfaction scores. This is the main purpose of the study - to explore if satisfaction scores can be linked to the room of discharge. This study hopes to confirm that some patient self-reported outcome questions have a relationship to the room that the patient occupied. This question will be further explored in the study to examine what elements of the room (i.e. specific spatial variables) could be creating that relationship.

3. Do certain categories or locations of rooms explain better room performance? (number of top box scores on average in the room of discharge during the study period?
    a. Is there a visual pattern of highest performing rooms?
    b. Is there a visual pattern of lowest performing rooms?

Upon establishing that there is a relationship between patient room and patient self-reported outcome score (MacAllister, 2014), a further investigation of the satisfaction scores and room relationship is explored in the next three questions (3-5), using the method that Hsiao and Tan (Chen, Boore, & Mullan, 2005; Hsiao & Tan, 2011) developed to visualize satisfaction scores to rooms of discharge. This visual map is a tool to begin to understand if there is a pattern of performance. The pattern of performance indicates rooms that are anecdotally thought to be strong performing rooms based on location and proximity on the unit. An example may be that a low performing room could be located by an elevator, as the elevator noise and the amount of traffic in that area may be something that would be creating the room performance issue. This is

a unique way of looking for cause in the review of room scores and specific questions analyzed are: Is there a reason for the highest performing rooms to be high or the lowest performing rooms to be low? Highest performing rooms are those that have an overall high average score based on all the surveys collected. All of the raw surveys collected that are coded to the room are then averaged for that one room over the study period. This average becomes what is defined in this study as room performance.

4. Are the individual satisfaction questions related? Does each question follow the same result?

Once the mean scores (an average score for each survey coded to the room) of the room performance are mapped onto the physical space, then the exploration of the patient self-reported outcomes may be further understood. The next research question is logically (4), are patient self-reported outcome scores correlated to each other? In other words, are certain questions within the survey interrelated? Did patients tend to rate consistently high or consistently low across the survey questions? Were the satisfaction scores always high, or low? This could influence the outcome to one direction or another or not be a clear representation of the outcomes.

5. Are the patients assigned to rooms randomly? Is there a correlation between room type/number and patient characteristics?

In a comparable way, could similar patients in the same room always make that room score high or low? The next research question to follow (5): Are the patients assigned to rooms randomly? This further validates the distribution of the patients as representatives and identifies if there would be any additional moderators that we may want to pay attention to in the analysis.

6. Do patient characteristics completely explain satisfaction scores?

The next logical review would be that the patient's characteristics, or their determinants, had a relationship to the satisfaction outcome. This leads to research question (6), are the overall satisfaction scores tied to the patient characteristics? This explores the known moderator (patient characteristics) that has been explored in the previous work completed in the patient self-reported outcome literature. It is known that there are certain determinants of a patient that will influence, or even predict, the outcome of their stay. This study will have a sample in which all patient types are distributed evenly over all room types to achieve a representative population sample.

7. Do room categories and unit types have significantly different patient profiles or patient characteristics?

The next question (7) defines the sample population by room and unit characteristics. With the moderated variable noted, and the representative sample distribution understood, it is now time to further explore the relationship of the patient self-reported outcome scores to the spatial variables that have been identified in the literature review as important components in the care delivery model.

8. Are Differences in satisfaction scores explained by spatial characteristics of the room and unit?

Question (8) determines if satisfaction scores are tied to the spatial variables. Finally, a further review is done to see if there is a difference in performance (% of top box scores) by spatial variable. Does the spatial variable have a relationship to the room of discharge? Is one characteristic of the spatial variable tied to a higher or lower outcome? An example of this may be that right-handed rooms have a higher number of top box scores than left-handed rooms.

9. What is categorical spatial variable performance? Explore the possible room type performance based on the findings from the analysis (number of top box scores in that room during the study period)?

At the final exploration of this study, question (9) is intended to look for possible quantifiable known spatial variables that may influence the individual survey, the room performance, and ultimately the hospital's overall score.

The variables and the analysis methods associated with these questions are further defined in Chapters Three and Four respectively. The use of various questions and analysis allow for full exploration of the variables and their plausible relationships. It has been noted that in architectural research, it is difficult to conduct rigorous, scientific causal studies when one is measuring the effect on humans of their natural environment (Devlin & Arneill, 2003). This study intends to focus on an exploratory methodology to define how one can quantitatively define a possible relationship.

Section 1: Methodology

2. Literature review

2.1. Patient self-reported outcomes and the relationship to spatial variables: a review of the literature

2.1.1. Introduction

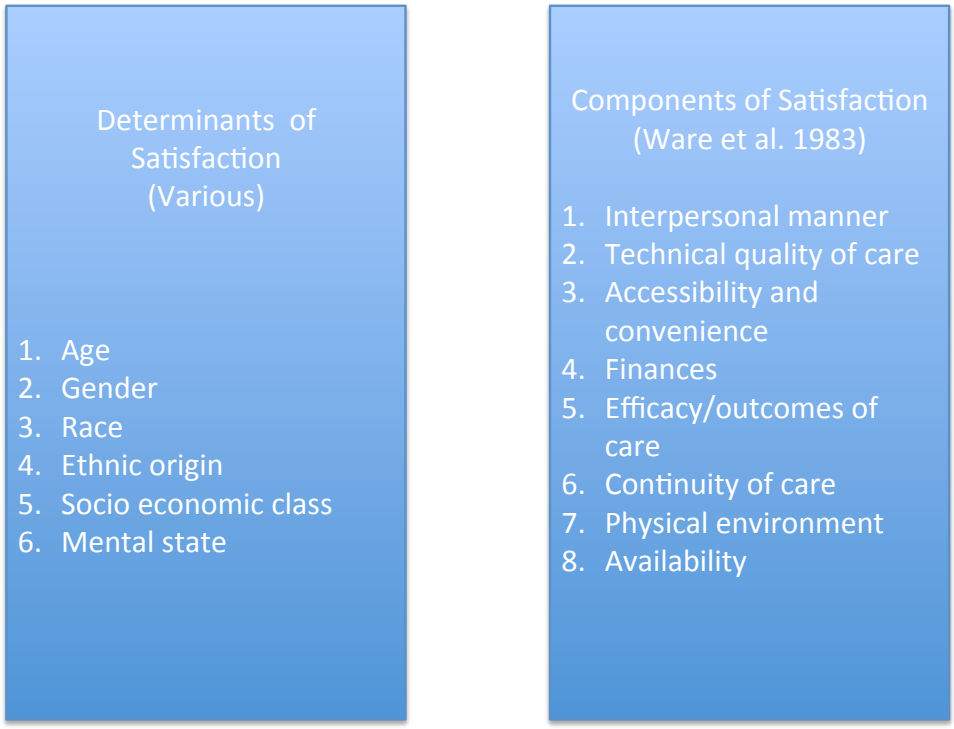
As the delivery of medical care has moved to evidence-based practices, there is a clearly defined universal protocol; the outcomes have become more predictable. Since the onset of evidence-based medicine in the 1990's, all medical research follows a clearly defined framework called PICO (problem, intervention, comparison, and outcome) (Guyatt, 1991). This model solidified the medical field's focus on health outcomes and quantified standards for diseases. With the focus on clinical outcomes, this created a significant variation in clinical quality across the United States (Corrigan, Donaldson, & Kohn, 2001). Quality is defined as treating the medical symptoms. The focus is not on the *experience* of treating the admitting symptom. Absent from this current model is the understanding of the patient's opinion of their own experience of care. With the introduction of Hospital Quality Program (HQP) (Jha, Li, Orav, & Epstein, 2005) all sectors of the United States payer systems, such as Centers for Medicare and Medicaid Services (CMS) and The Joint Commission, are evaluating hospitals by shared quality measures. A key component of these quality measures includes the patient's perception of care, along with health related outcomes. Similar initiatives have happened globally, such as the United Kingdom's government policy in 1987, *Promoting Better Health* ("Promoting Better Health: The Government's Programme for Improving Primary Care," 1987), the Consumer Satisfaction Center at the University of Siena's Quality Perception Questionnaire (Furnham et al., 2012), and initiatives in other countries. This shift begins to examine the importance of the patient's perspective of care as being as significant as the health related outcome. This interest created the field of patient satisfaction (Sitzia & Wood, 1997) which was derived from the service quality industry and job satisfaction (Larrabee et al., 2004).

2.1.2. Patient Satisfaction overview

The field of patient satisfaction was defined through the early work of Ware et al. (Ware, Snyder, Wright, & Davies, 1983). They defined patient satisfaction as a reflection of preference, expectations, and the reality of care. In the seminal work reviewing the research of the field, Sitzia and Wood (1997) defined the influencers of patient satisfaction in two classifications: *determinants* of satisfaction and *components* of satisfaction.

The *determinants* of satisfaction are a person's individual characteristics and their expectations. The patient variable that has shown to influence satisfaction, and is widely accepted as a determining factor, is that older patients are generally more satisfied than younger ones (Calnan et al., 1994; Cleary et al., 1991; Hall Judith A., 1990; Henley & Davis, 1967). Gender and race however, are not influencing factors or determinants of satisfaction (Marple, Lucey, Kroenke, Wilder, & Lucas, 1997; Zastowny, Roghman, & Hengst, 1983). Other determinants of satisfaction investigated show a possible relationship to education level, where less educated patients are more satisfied (Hall Judith A., 1990). There have also been studies exploring ethnic origin (Pascoe, 1983) and socio-economic class (Hall Judith A., 1990) which have had mixed reviews. The understanding of the determinants of satisfaction is important, as it relates to the patient population. The understanding in the industry is that patient characteristics are treated as known variables that are not easily influenced outside of population changes. Therefore, the variables are treated as independent variables (Sitzia & Wood, 1997) or as unalterable factors (Thi, 2002).

Figure 2-1 Identified determinates and component variables that have shown to influence patient satisfaction through research



The other classification Sitzia and Wood (1997) identified was the *components* of satisfaction based on the care, or the processes of care, delivered. The classification system that Ware et al. introduced in 1983 has been used to frame much of the research in this area (Ware et al., 1983). His team identified eight components of satisfaction, of which the physical environment was one (Figure 2.1). The aspects of the environment noted in the Ware et al. (Ware et al., 1983) study, along with Harris et al. (Harris et al., 2002a) and Zimring et al. (Zimring, Reizenstein Carpman, & Michelson, 1987), each focused on more aesthetic or ambient environmental features such as 'physical comfort,' 'orderliness,' and 'pleasant atmosphere.' The role of the environment in patient satisfaction is noted in more recent work, though it is still focused around the ambient environment (Swan et al., 2003) - how a room looks and feels. These physical, environmental components have also shown up in the Hospital Consumer Assessment of

Healthcare Providers and Systems (HCAHPS) survey. (see Appendix A) This survey, in the United States, is the way that data is collected and comparatively ranked and systems reimbursed for the quality of the care they provide. The hospital environment has two specific questions that follow in line with the previous research work cited above. These questions ask if the room is clean and quiet. (Appendix A ("Hospital Consumer Assessment of Healthcare Providers and Systems," 2015)). It is not surprising that the questions asked are tied to the defined link of environment to ambient features, as this has been the focus of much of the field. More recent research in the field has shown definitively that there are physical environment features that could influence system performance of the components of satisfaction (Siddiqui et al., 2014).

2.1.3. The meanings of physical environment

As reviewed above, much of the work in the field of patient satisfaction as a measure of service quality has identified environmental influences tied to ambient environment. There has been significant work in the fields of evidenced-based design and environmental psychology that has linked health outcomes such as falls and mortality to architectural features (spatial variables) like room layout and visibility (Leaf et al., 2010; Y. Lu et al., 2014). Harris, et al. (Harris et al., 2002a) appropriately identifies the difference between ambient, or sensory, elements and architectural features (spatial variables) as the more fixed elements. The research cited focuses around way finding (Carpman & M.A., 1993) and views from the patient's bed (Ulrich, 1984) with limited examination of how these elements could impact the patient's satisfaction. More recent work by Andrade et al. (Andrade, Lima, Fornara, & Bonaiuto, 2012) and Fornara et al. (Fornara, Bonaiuto, & Bonnes, 2006) is exploring the linkages of hospital quality indicators to the physical environment. The work is still looking to identify factors of the environment such as lighting and quality of the finishes. The linkages fall short of the medical outcomes or touching on the other components of satisfaction noted by Ware et al. (1983).

The intent of this work is to move beyond the obvious environmental factors and move to the subtleties of the interplay of space and people in the interpersonal aspects of care - the unconscious interplay that will specifically focus on nursing unit care and the environments ability to support the non-verbal interaction. As noted by Sitzia and Wood (1997) body positions, distance, location, and posture can all be influencers of interpersonal interactions of satisfaction. It was also found that when physicians leaned into a patient when they spoke to them, made eye contact, or nodded, the perception of care was higher (Kendon, 1970; LaCrosse, 1975; Larsen & Smith, 1981; Sitzia & Wood, 1997). Further, when the nurse's interpersonal relationship is empathetic and kind, the satisfaction outcomes are mostly higher than non-empathetic interactions (Kadner, 1994; Tishelman, 1994). Nursing interaction was ranked one of the highest influencers of satisfaction outcomes (Burroughs, Davies, Cira, & Dunagan, 1999; Tzeng & Yin, 2009)

In review, studies looking at patient satisfaction from various fields (patient satisfaction, quality improvement, architecture, and environmental psychology) have included environment in its ambient form as a part of the studies, however, the greater role of the environment as a facilitator of improved operations has been absent. There is a clear relationship of the role that the environment has to observed behavioral outcomes. This relationship has been explored in the field of environmental psychology and evidence-based design showing the link between the subtle interplay of space and people and its ability to support behaviors (Cai & Zimring, 2012).

2.1.4. Focus of the literature review

The delivery of medical care is defined as both reducing the medical symptoms of a patient and creating a satisfying experience. The ability to satisfy the patient has limitations based on the determined individual characteristics; however, the care component can be influenced. The role of the environment in reference in this study is not the obvious clean, quiet, and aesthetically pleasing outcome. The role of the environment is defined as the subtle influence of how spatial layouts can impede or enhance an operational processes success. This

has been demonstrated in previous studies that show the environment can influence the care delivery and operations (Cai & Zimring, 2012; Choi et al., 2011; Pati, Cason, Jr, & Evans, 2010; Rashid, Kampschroer, Wineman, & Zimring, 2006). This literature review will first explore the relevant research in the field that clearly links architectural environmental factors (spatial variables) to outcomes. After the studies are identified, the architectural variables will be catalogued and summarized based on the components of satisfaction: the physical aesthetic environment and the interpersonal aspects of care. Within these studies, they each identify a spatial component that directly or indirectly impacts the patient outcomes in the quality of their care delivery. This emerging field has few peer-reviewed research studies that investigate, through field or lab studies, the relationship of spatial layout and human behavior and outcomes in a healthcare setting.

2.1.5. Literature review methods

This literature search and exploration of relevant studies was done through the use of various academic search engines such as PubMed, EBSCO, and JSTOR and common internet search engines using key words: satisfaction, patient satisfaction, health outcomes, environment outcomes, healthcare quality, and organizational culture. Included studies were published in English language peer-reviewed journals with a clear causal model established and tested.

Over 50 studies were found through various searches and the author reviewed each study for its research structure with clearly defined variables and with the predictor variable being related to room or unit layout and an outcome that was related to a health behavior. From the 50 found studies only 14 were deemed to be rigorous in the research analysis and had a clear spatial variable and a hospital outcome variable. The inclusion criteria for the 14 selected studies were a clear statistical analysis, spatial variable, and an outcome variable that was related to a health outcome (ie: mortality, falls, or re-hospitalization rates). Each study was carefully reviewed and evaluated into comparable units of study: participants, predictor variable, control variable, outcome variable, analysis method, unit of analysis, and findings (Table 2.1).

Table 1 allowed for the author to then sort the studies using the identified variables and outcomes into two categories: physical aesthetic environment and interpersonal aspects of the care environment. First, physical and aesthetic environment uses the visual comfort aspects of care as noted by scholars (Devlin & Arneill, 2003; Evans & McCoy, 1998; Fornara & Andrade, 2012; Fornara et al., 2006) including appropriate lighting, sound, and climate along with pleasing views, artwork, colors, cleanliness, and nature. The second category of interpersonal aspects of care included behavioral influencers of space identified by scholars. This includes the field of work that has been discussed and explored in the field of environmental psychology.

Table 2-1 Evidence table from the literature review of spatial variable that have demonstrated influence to health outcomes

Reference Study	Summary of study	Participants	Predictor Variable (spatial)	Control Variables	Outcome Variables	Analysis	Unit of Analysis/ n	Findings
Pati, D., Cason, C., Harvey, T. E., Jr., & Evans, J. (2010). An empirical examination of patient room handedness in acute medical-surgical settings. Health Environments Research and Design Journal, 4(1), 11-33.	This within- subjects study conducted in a nursing simulation lab explored the impact of the standardization of inpatient room layouts ("same-handed rooms") on the standardization of nursing workflow and process. Nurses were videotaped performing three tasks in each of nine layouts on a mock patient (approaching from patient's left, right or unconstrained) each with an IV on patient's right, left or no IV. The video tapes and follow up interviews were coded by independent coders to assess standardization of behavior.	10 right handed nurses and 10 left handed masters-trained nursing students and faculty members, mean age of 53 and mean of 27 years experience	Categorical: 9 room layouts (left/right/unconstrained approach x IV on right/left/no IV)	Spatial variable standards: height of pt bed, bed angle, bed rails up, over bed table centered, suction canister, dynamap at rn station, suction kit at rn station Participants conducted same tasks	Categorical (present/absent) and frequency of behaviors from video tape analysis: direction of approach, any hesitation in approach, over bed table use, bed rail adj, bed height adj, postures	logistic and poison regression	Nurse	The study found that direction of approach did not predict outcomes. The authors concluded that other factors such as presence of devices like IV's and individual preference were more important predictors of behavior.
Ulrich, R. (1984). View through a window may influence recovery from surgery. Science, 224(4647), 420-421.	This study is a retrospective look at the outcomes 26 pairs of similar patients and their varied outcomes based on the room they were assigned. It was found that medication doses were greater in the room that had a view to the brick wall. Rooms with views to the trees had fewer complaints or complications from the surgery.	Patients age 20-69 years old at a suburban Pennsylvania hospital between 1972-1981 whom had cholecystectomy surgery only without complications.	Categorical: Room with view to a grove of trees or brick wall	Nurse assignment, double occupancy patient room. Room dimensions, window size arrangement of the bed and furniture. Tried to control for Physician but this was not accomplished	Patient outcomes. Number of days in the hospital, number and strength of analgesics each day, number and strength of doses for anxiety, minor complications, persistent headache and nausea and patient notes on recovery	Wilcoxon matched pairs, signed-ranks analysis. Multivariate two-sample Hoteling test	patient	Rooms with view to nature impacted the patient's outcome of pain requirement and length of stay.
Rashid, M., Kampschroer, K., Wineman, J., & Zimring, C. (2006). Spatial layout and face-to-face interaction in offices–a study of the mechanisms of spatial effects on face-to-face interaction. Environment and Planning B: Planning and Design, 33(6), 825-844.	This study investigated the impact of visual copresence and face-to-face interactions on office culture and productivity in different office building layouts. Visual copresence was defined as a clear point of observation that allowed for visibility between people: face-to-face interactions were defined as reciprocal exchanges between people.	Office buildings	Visibility, Accessibility, openness, visibility copresence, movement, face to face interaction	office location or culture	increased communication, improved coordination, formation of group, organization agility, even information	observation and Space Syntax	individual Or spatial location/ n	Findings identified that the physical layout of space is important to improve movement and the person's productivity and revealed through a space-syntax analysis that the connected spaces did not predict a change in interactions or copresence.

Table 2-2 Evidence table from the literature review of spatial variable that have demonstrated influence to health outcomes

Reference Study	Summary of study	Participants	Predictor Variable (spatial)	Control Variables	Outcome Variables	Analysis	Unit of Analysis/ n	Findings
Blomkvist, Eriksen, Theorell, Ulrich, and Rasmanis,(2005) "Acoustics and psychosocial environment in intensive coronary care," Occupational Environmental Medicine 62	The focus of this study on noise or "unwanted sound" was not solely based on the decibel levels but it looked at the further impacts of reverberation in the space. This study takes a different look on noise outside of the previous research by Norbeck (Norbeck, 1985) and others that demonstrated a connection of higher stress levels with a perceived higher noise level by staff. The main purpose of this work was to look deeper into the levels of noise and the effects of the environments acoustical properties. These acoustical properties and noise could impact the occupants that are working in those spaces by self perception of psychosocial effect.	50 cardiac Nurses over 42 weekdays and nights. Staff self reported psychosocial questions at two points in the day.	acoustical properties of 7 patient rooms and the central nurses station. Categorical: reflective and absorptive	staff tasks, work volume and the physical work environment. The number of patients in the CCU varied.	psychological measures including staff fatigue	Post hoc test and Analysis of Variance	staff survey by shift	The results of this study showed an impact of the psychosocial environment later in the day for the sound absorbing tiles. The staff were less fatigued by noise exposure throughout the coarse of the day with the sound absorbing tiles. While both tiles met the requirements of the regulatory guidance there was a noticeable impact to the lower sound pressure levels that had the sound absorbing tiles.
Leaf D., Homel P., Factor P., (2010) Relationship Between ICU Design and Mortality. Chest, 137, 1022-1027	This study explores the relationship of patients room location and the ability to be seen to their mortality rates.	664 patients admitted to the MICU (Medical ICU) during 2008 to Columbia University Medical Center	Categorical: direct line of sight between observer and any part of the patient Low visibility rooms (LVR) and High Visibility rooms (HVR)	one unit. Staffing and room assignments varied. Non isolated patients	Primary was Hospital mortality. Death prior to discharge. Secondary ICU mortality, ICU length of stay in MICU before mortality, ventilator free days	Normally distributed data (Kolmogorov-Siminov test). Difference between groups t test and Mann-Whitney U test. Groups assessed with Fisher exact test and X2. Logical regression for room and outcome.	patient by group- 664	mortality did not differ by room type overall. The very ill patients did have higher mortality in LVR's.

Table 2-3 Evidence table from the literature review of spatial variable that have demonstrated influence to health outcomes

Reference Study	Summary of study	Participants	Predictor Variable (spatial)	Control Variables	Outcome Variables	Analysis	Unit of Analysis/ n	Findings
Cai H., Zimring C. (2012) Out of Sight, Out of Reach. Correlating spatial metrics of nurses station typology with nurses' communication and co-awareness in an Proceedings intensive care unit.	This comparative study looks to further identify spatial measures for nurses stations in Emory Hospital ICU. The study hopes to further define the tools for design use in nursing unit design.	2 ICU Units at Emory Hospital	Components of the nurses station		behavior and integration of staff communication	spatial analysis and behavior mapping, awareness network analysis. T test, tukey's test		the findings of this study identified that there is a strong relationship of the nurses observed behavior and co awareness and nurses station layout.
MacAllister, Zimring (March 2014) The Impact of Spatial Layouts on Patient Satisfaction. Georgia Institute of Technology Qualifying Paper	This study looks at the relationship of the room layout and its impact to the patient satisfaction outcome.	2,598 patient surveys of 2 cardiovascular units at Emory University Hospital over 5 years	Room layout features categorical. Sink location, bed location, bed orientation, distance to the nurses station	Patient Characteristics and staffing culture and organization	Satisfaction scores	multiple linear regression, ANOVA	56 patient rooms	correlations between room layout and patient satisfaction.
Lu, Y., Ossmann, M. M., Leaf, D. E., & Factor, P. H. (2014). Patient visibility and ICU mortality: A conceptual replication. Health Environments Research & Design Journal, 7(2), 92-103.	This study further explores the possible relationship of room location and mortality. In this study the information from the initial study is reanalyzed for the rooms targeted visibility.	664 patients admitted to the MICU (Medical ICU) during 2008 to Columbia University Medical Center	Spatial variable. Patient visible head, patient room visibility, field of view to the nursing station		Patient morality	visibility analysis syntax	12 patient room	the field of view of patient rooms accounted for 33% of the mortality variance. There may be subtle effects on clinical outcomes.

Table 2-4 Evidence table from the literature review of spatial variable that have demonstrated influence to health outcomes

Reference Study	Summary of study	Participants	Predictor Variable (spatial)	Control Variables	Outcome Variables	Analysis	Unit of Analysis/ n	Findings
Cai, H. (August 2012). MAKING "INVISIBLE ARCHITECTURE" VISIBLE: A COMPARATIVE STUDY OF NURSING UNIT TYPOLOGIES IN THE UNITED STATES AND CHINA. Dissertation. Georgia Institute of Technology.	This comparative study looks at the nursing units in China and the US and compares them spatially. Looking at the spatial impact of organizational culture through face to face integration and communication.	12 Hospital nursing units	nursing unit design. Space economy, staff efficiency, natural light and culture		Behavior	axial maps and visual graphics	12 nursing units	the metric analysis is be better predictor of outcomes of coawareness.
Lu Y. (May 2011) DIRECTED VISIBILITY ANALYSIS: THREE CASE STUDIES ON THE RELATIONSHIP BETWEEN BUILDING LAYOUT, PERCEPTION AND BEHAVIOR. Dissertation. Georgia Institute of Technology.	This study looks at the how buildings are organized to support organizational culture through visual patterns either generic or directed.	the staff of a 20 bed ICU/ 11 RN's 1 Nurse manager, 3 Nurse Practitioners, 1 attending physician, 2-3 resident physician	unit visibility		staff behaviors	Targeted and visibility space syntax analysis, pearsons correlation	number of patients beds visible from a given location	staff in the environment are influenced by different aspects of the environment. Nurses distribute more deliberately within the unit. Physicians locate at the higher visibility area.
Hendrich A., Bender P., Nyhuis A., (2003) Validation of the Hendrich II Fall Risk Model: A Large Concurrent Case/Control Study of Hospitalized Patients, Applied Nursing Research, Vol 16, No. 1, 9-21.	This study was to use the previous work that has looked at possible factors of falls for patients. The purpose for this study was to develop a predictive model for all the population to identify fall risk factors of individuals.	Patients at a 750 bed acute hospital over 2 year period. 355 fall patients and 780 control population	medical factors of the patient, 600 variables including psychological, patient demographics, patient medical results, patient diagnosis, fall risk measures and medication data	780 control population	predictive risk factors for falls.	chi squared	patient	Results validate the risk related tool that was created to identify possible fall risks for patients. This tool can be used to provide indicators to staff of a heightened risk of fall for the patient.

Table 2-5 Evidence table from the literature review of spatial variable that have demonstrated influence to health outcomes

Reference Study	Summary of study	Participants	Predictor Variable (spatial)	Control Variables	Outcome Variables	Analysis	Unit of Analysis/ n	Findings
Choi Young Seon, (2011) The Physical Environment and Patient Safety: An Investigation of Physical Environmental Factors Associated with Patient Falls. Georgia Institute of Technology Dissertation.	This case controlled study looked at Dublin Methodist Hospital in Dublin Ohio with 5 inpatient units and room layout environmental factors that had a relationship for patient falls.	94 reported falls in five inpatient units over 3 years. 88 falls in medical surgical unit were analyzed	patient room layouts. Visibility of spatial area in the room, visibility from nurses station, accessibility to a patient, distance from medication, bathroom location	148 controlled subject of similar patient profile. (age, gender, admitting diagnosis and DRG)	Patient fall or likelihood to fall.	descriptive analysis, visual representation of falls, pearson correlation, chi square test, multivariate logistic regression analysis	Patient	Results indicate that there were environmental factors that influenced fall rates in patients when their head was not visible from the corridor. The environment in particular and the visibility within the environment to the patient and other staff for co awareness for organizational functioning impacts falls as well.

2.1.6. Physical aesthetic environment

As was stated previously, in the field of architectural research there are elements known as aesthetics such as paint color and pictures. In review of the literature there were four studies that looked at the physical, aesthetic environmental influence on health outcomes. The studies are briefly summarized below, identifying their purpose and outcomes and exploring the spatial variables of both views and noise.

Ulrich (1984) study of surgical recovery is a retrospective look at the outcomes of 26 pairs of similar patients, and their varied outcomes, based on the room to which they were assigned. The rooms were identified as being either a room with a view to nature or a room with a view of a brick wall. It was found that medication doses were greater in the room that had a view to the brick wall. Rooms with views to the trees had fewer complaints or complications from the surgery. Statistically significant findings indicated that rooms with a view to nature impacted the patient's outcomes including pain and length of stay.

In a laboratory study measuring the impact of reverberation time on sleep, Berg (2001) compared sleep with and without sound absorbing ceiling tiles when subjects were exposed to a variety of noises. The tests and analysis of the data found that there was a plausible relationship between arousal to the sound stimulus at the onset of sleep phase one and two. The variation in the sound environment did not impact the person's stage of sleep or the duration of that stage. The findings proved that there was a possible impact on sleep fragmentation when acoustical absorbing ceiling tiles were placed in the environment.

The Hagerman et al. (2005) and Blomkvist et al. (2005) studies also looked at the impact of absorbing ceiling tiles on patient and staff outcomes in an intensive coronary care unit. The Hagerman et al. (2005) study investigated how patients could be impacted through a work environment that had poor sound absorption. This hypothesis begins to link how sound quality within a work environment can exacerbate the occupant to a point of poor clinical outcomes for

the patient. The results of the study showed little change with the physiological outcome measures when comparing means across the two sample patient groups (good vs. bad acoustics). However, significance in the study was discovered when the sample groups were further separated by the degree of the disease. Specifically, the pulse amplitude in the acute myocardial infarction and unstable angina pectoris patient groups were significantly impacted by the two acoustical environments. Additionally, incidence of re-hospitalization was lower and staff attitude was perceived to be better by patients in the good acoustics condition.

The effects of sound absorption on staff was further explored in the Blomkvist et al. (2005) study. This study takes a different look at noise outside of the previous research by Norbeck (1985) and others that demonstrated a connection of higher stress levels with a perceived higher noise level by staff. The main purpose of this work was to look deeper into the levels of noise and the effects of the environment's acoustical properties on occupants that are working in those spaces. The results of this study showed an impact on the psychosocial environment later in the day and after sound absorbing tiles were installed. The staff were less fatigued by noise exposure throughout the course of the day with the addition of the sound absorbing tiles. While both the absorbing and reflecting tiles met the requirements of the regulatory guidance on acceptable noise levels, there was a noticeable impact on occupants during the lower sound pressure levels when the acoustics were improved.

These studies support the previous discussion of the ambient environmental influence of views, noise, and reverberation. Showing influence of patient stay, re-hospitalization, staff fatigue, and patient sleep the noted research is significant to the field.

2.1.7. Interpersonal aspects of care environment

The interpersonal aspects of care include studies that have demonstrated impact on health outcomes through spatial variables such as room and unit layout. These studies are focused on the intricacies of human behavior and their interplay with the environment as noted

earlier. The studies explore spatial variables of room handedness, visibility, and nursing unit and nursing station layout.

Pati et al. (2010) conducted a within-subjects study in a nursing simulation lab, exploring the impact of the standardization of inpatient room layouts ("same-handed rooms") on the standardization of nursing workflow and processes. Nurses were videotaped performing three tasks in each of nine layouts on a mock patient (approaching from patient's left, right, or unconstrained) each with an IV on patient's right, left, or no IV. The video tapes and follow up interviews were coded by independent coders to assess standardization of behavior. The study found that the direction of approach did not predict outcomes. The authors concluded that other factors, such as presence of devices like IV's and individual preference, were more important predictors of behavior.

In the review of ICU design and mortality, Leaf et al. (2010) explores the relationship of patient room location and their mortality rates. Mortality did not differ by room type, overall, though the very ill patients did have higher mortality in lower visibility rooms. Building on the Leaf et al. (2010) study, Y. Lu et al. (2014) used logistical regression and the Mann-Whitney-U test to explore the possible relationship of room location and mortality. In this study, the information from the initial study is reanalyzed for the room's targeted visibility. The field of view of patient rooms accounted for 33% of the mortality variance. There may be subtle effects on clinical outcomes - this will be further reviewed in later studies.

Rashid et al. (2006) investigated the impact of visual co-presence and face-to-face interactions on office culture and productivity in different office building layouts. Visual co-presence was defined as a clear point of observation that allowed for visibility between people: face-to-face interactions were defined as reciprocal exchanges between people. Findings identified that the physical layout of space is important to improve movement and productivity and revealed, through a space-syntax analysis, that the connected spaces did not predict a change in interactions or co-presence.

In another research study of ICU's at the University Hospital at Emory, and in a further exploration of co-presence, Cai and Zimring (2012) looked at communication variation based on nursing station layout. This comparative study looks to further identify spatial measures for various nurse's station layouts. The findings of this study identified that there is a strong relationship between the nurse's observed behavior and co-awareness as seen in the nurse's station layout. This further defines the tools for designs used in nursing unit plans. Cai (2012) continued her work with this comparative study by looking at the nursing units in China and the United States and comparing them spatially to see if there may be an impact on organizational culture through face to face interaction and communication. Both of these studies further define the importance of co-awareness, or visibility, and human behaviors.

Y. Lu (2011) explored further how occupants tune their behavior to the visual / spatial components of the environment. This study looks at the how buildings are organized to support organizational culture through visual patterns, either generic or directed. Staff in the environment are influenced by different aspects of that environment. In a healthcare environment, in the same Emory ICU, nurses were found to distribute more deliberately within the unit while physicians locate at the higher visibility areas. This study demonstrated the importance of visual connection in many environments and the complexity of spatial layering to accomplish these connections to influence behaviors.

With the understanding derived from Lu on the importance of the visual / spatial component of the environment, a further exploration was conducted to see if there is a connection between patient falls and the spatial environment. The spatial impact of falls has been examined in two specific studies. The first, by Hendrich, Bender, and Nyhuis (2003), used previous studies of possible factors of falls for patients. The purpose of this study was to develop a predictive model for the entire population to identify fall risk factors of individuals. The other study, by Choi (2011), was a case-controlled study looking at Dublin Methodist Hospital in Dublin, Ohio with five inpatient units and room-layout environmental factors that had a relationship with patient falls.

Each study demonstrated the importance of visual awareness in relation to the impact of patient falls with statistically significant findings.

Finally, MacAllister (2014) explored the possibility that room layout could influence the patient's experience of care. In particular, this study looked at the relationship of the room layout and its impact to the patient self-reported outcome. Relationships between room layout and patient self-reported outcome were found in the spatial variables of room layout and bed orientation, room location, and orientation of the first encounter in the room.

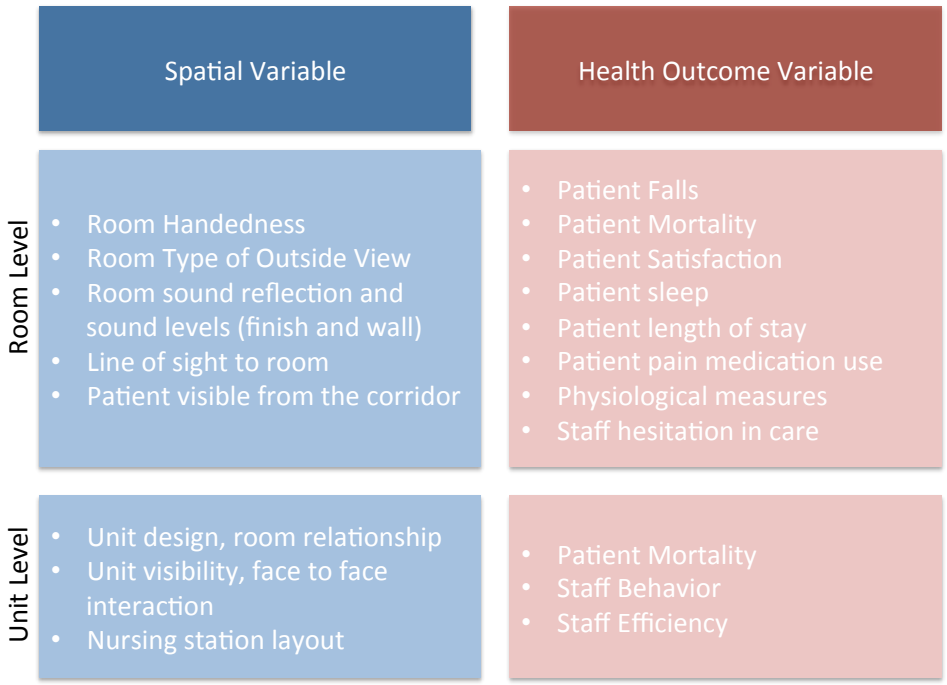
2.1.8. Summary

The intent behind this literature review was to seek out studies that further define the environmental components that have a direct tie to behavioral outcomes in healthcare, such as the work of Drs. Leaf and Factor (Leaf et al., 2010; Y. Lu et al., 2014). The variables that are noted as spatial influences in many of the studies focus around visibility and the ability to see or engage with others without spatial restriction. The other spatial variable of note is acoustics. This also has been shown to impact outcomes such as patient sleep, re-hospitalization, perceived staff attitude, staff fatigue, and the psychosocial environment (Berg, 2001; Blomkvist et al., 2005; Hagerman et al., 2005). As these studies are further reviewed in detail, the key components that have shown a plausible outcome to the patients and staff is the spatial relationships of walls, rooms, and their proximity to the patient's bed and the nurses' station. These critical variables of interest in nursing unit design and room and wall placement are critical to the successful health outcomes of the patient.

The review of the literature in this area demonstrates that the spatial environment has an impact on interpersonal or relationship-based care and also on the aesthetic environment and its influence on the outcomes. In the aesthetic components, it was found that rooms with a view and lower sound levels and reverberation times improved outcomes such as patient sleep, pain levels, and reduced the length of stay (Figure 2.2). In the interpersonal aspect of the environment, or the operational aspect of care, it was found that the spatial configuration of

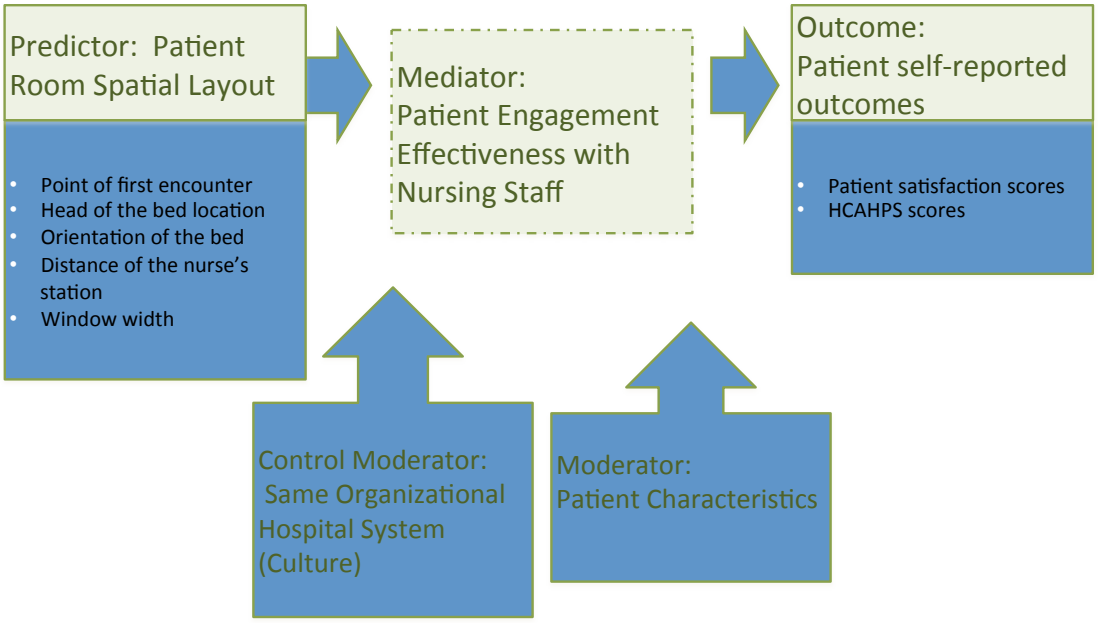
visibility, room handedness, and nurse's station location all contributed to falls, mortality, satisfaction of patients, and improved staff behavior. The blending of the two predictors of patient characteristics and the spatial components will provide the basis of known influencers in a person's behavioral outcome.

Figure 2-2 List of spatial variable and identified health outcomes generated from the literature review



3. Definition of the variables

Figure 3-1 Overall causal model that represents the framework for this research study. This study examines the relationship of patient satisfaction and spatial layout. The mediators and moderated noted for study in future work.



This chapter provides a description of all variables identified for this study, as shown in figure 3.1, as they relate to the exploration of the causal model. As was noted in the literature review there are key spatial variables that have been identified through the evidence. The definitions and the measurements examined in this study were derived from the literature. The chapter begins with the overview of the spatial variables used in this study. It then moves to the possible moderating variables of patient characteristics and hospital organizational culture. Finally, this chapter reviews the patient-reported outcome variables included in this study. Systematically identifying all the variables will help to provide guidance for improved analysis in future studies.

3.1. Spatial predictor variables

The spatial variables identified for this study were derived from the literature search and exploration of studies with established influence on aspects of care and the environment in Chapter Two. The goal of this study is to build on established spatial variables that have been shown to be an influencer in health or quality outcomes. With the use of these previously studied variables, we do not need to establish further reasoning or measurement techniques for inclusion in this study. The research will add to the possible significance of these known variables of influence in the patients' aspects of care. Each variable will be summarized with relevant citations and support, along with the measurement methodology used for the present study. All spatial variables were calculated based on AutoCAD electronic floor plan files received from the hospital and observations completed at various times to validate the location and orientation of all rooms and units included in this study.

The variables included will be distance to the nurse's station, room handedness, bed location, location of first encounter, and window opening (Table 3.1). All of these variables were identified in the literature review and further cited below for their significance and importance as key components in the care delivery process.

Table 3-1 Spatial categorical variables identified for this research study

Study Variable	Role	Categorical Measure	Data source
Spatial Variable			
Distance to the nurse's station	predictor	Distance to the Rn Station (feet) Numerical/ 3 Distance Categories: Short 1-35 ft, Medium 36-70 ft, Long 71 ft +.	EUH AutoCAD
Room Handedness	predictor	2 categorical (right and left)	EUH Observation
Bed Location	predictor	2 Categorical (in and door)	EUH Observation
Location of first encounter	predictor	3 Categorical (in, facing, back)	EUH Observation
Window opening length	predictor	Window size (feet) numeric /3 Categorical (small, medium, large)	EUH Observation
Room number	predictor and outcome	numerical / 81 categorical room types	EUH-Press Ganey
Unit number	predictor and outcome	3 Categorical (B, G, E)	EUH-Press Ganey

3.1.1. Distance to nursing station

In this study there are three separate unit types, bar, racetrack and triangular, all with central nurses stations. The distance variable in this study began at the centerline of the door of the patient's room and then to the center line of the corridor. The distance continued to the nearest nurse's station and entry and then ended at the center line of that door entry (Figure 3.2). While this distance will vary by each room in this study, with the various room locations, numeric variables are created to further cluster room types. These clusters were as follows: category one is 1 foot to 34 lineal feet, category two is 35 lineal feet to 67 lineal feet, category three is 68 to 99 lineal feet, and the final category is 100 lineal feet and above. The three categorical lineal distances were defined by equal distribution of all three units with the defined room length. There were three clear groupings of room distances from the central nurses station that were created. Through the review of previous studies it was anticipated that the highest performing distance could plausibly be the middle rooms.

Figure 3-2 Spatial variable, distance to the nurse station is measured from the edge of the nursing station through the center of the corridor to the middle of the entry to the patient room in three categories (short, medium, long)

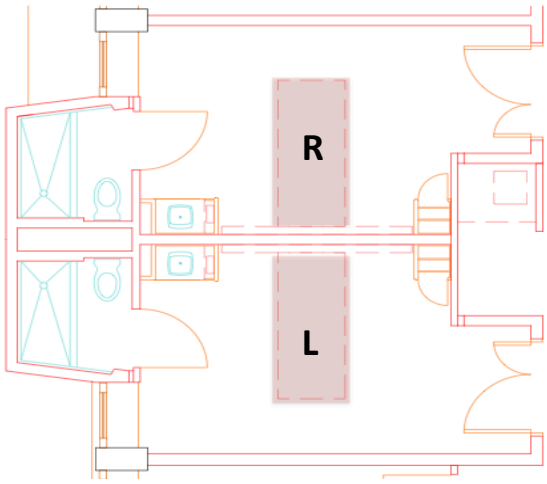
3.1.2. Room Handedness

In the advent of increased patient safety and quality issues in healthcare, there has been a growing discussion regarding the care provider's approach to the patient's bed (i.e., room-handedness). Identical room layouts (i.e., same-handed rooms) throughout nursing units are thought to decrease medical errors and improve staff efficiency. Pati et al. (2010) investigated the impact same-handed rooms had on staff efficiency. While they found that there was little association between bed orientation and staff efficiency, this study looks to further explore the possible impact of room handedness on the perception of care received through patient self-reported outcome. .

Pati et al. (2010) focused on the orientation of the bed and its relationship to safety and staff productivity but did not investigate the impact on patient satisfaction. Healthcare providers are generally trained to approach patients and deliver care from the right. In left-handed rooms, staff may need to move further into the patient and family zone to deliver care. Might staff intrusions into the family zone adversely affect patient satisfaction?

This study identifies rooms categorically by right- or left-handedness (Figure 3.3). This is established by the way the patient would be oriented in the room. A left-handed room is one where the patient's left side is closest to the door. The right-handed room is where the patient's right side is closest to the entry door. While the work that was previously reviewed identified that there was not conclusive evidence to show that room handedness does not impact the outcomes it is thought that this will hold for the patient self-reported outcome as well. This would settle the room handedness discussion for once as room orientation has no impact operationally or perceptually.

Figure 3-3 Spatial variable, Room handed is measured by the orientation of the patient on the bed in two categories (right, left)

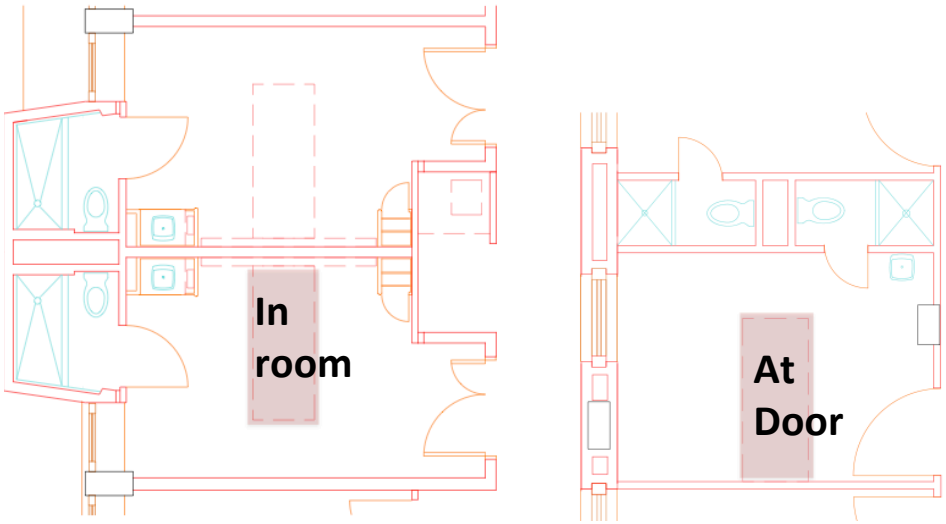


3.1.3. Bed Location

The location of the bed within the patient room is another factor that may impact the safety and quality of care, as well as patient self-reported outcomes. Current research reveals that patients in beds that are visible from the corridor are less likely to fall than patients in beds that are not visible (Choi et al., 2011). Placement of the patient bed on the door side of the room improves visibility but may also greatly compromise patient privacy and increase noise transmission into the room; thus negatively affecting patient self-reported outcome (Figure 3.4).

This study identifies the location of the bed as either within the room or at the door. This categorical variable differs by unit and by room. The majority of the rooms are within the room while a handful of beds are placed at the door on various units. It is thought based on the previous statements above that beds located within the room will perform higher then beds at the door for patient self-reported outcomes.

Figure 3-4 Spatial variable, location of bed is measured by how the bed is placed in the room in two categories(in room, at door)



3.1.4. Location of the First Encounter

How can space improve a practitioner's interaction with their patient? In this study, a novel variable of analysis was developed to try and measure the most critical interaction in a patient's room – 'the first encounter'. The initial encounter between the staff member and the patient in the patients' rooms can be measured by the location of the hand wash sink. All patient rooms in the United States are required to have a sink for staff to wash their hands upon entry for infection control. This initial connection of the staff member and the patient is called, in this study, the location of first encounter. As a novel concept and variable, the theoretical premise is derived from the notion that the staff member's ability to make eye contact with the patient can potentially change the perceived experience.

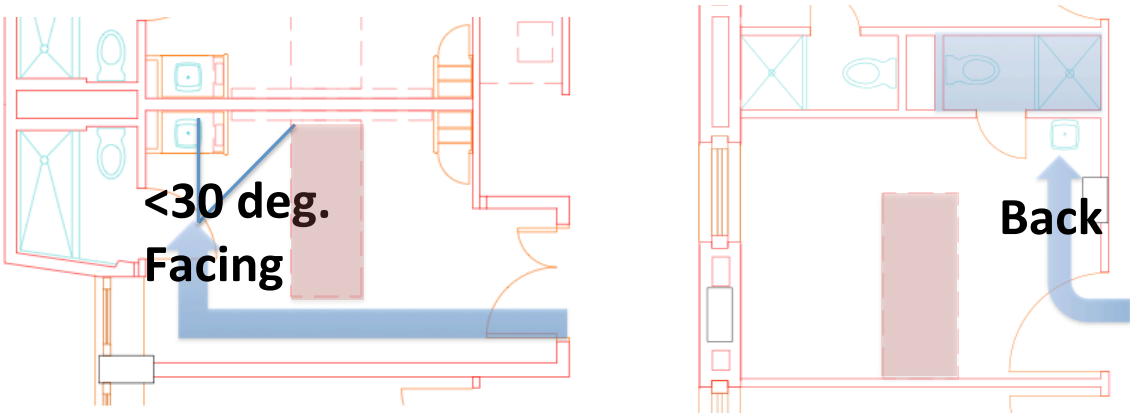
Research supports that visual connections in office cultures has shown influence on social networks (Rashid et al., 2006). The research operationalized visual co-presence, or connection, as a clear point of observation that allowed for visibility between people: face-to-face interactions were defined as reciprocal exchanges between people (West, 2013).

Increasing connectivity, or altering the positioning of critical room components, can impact the behavior or an occupant's ability to engage in reciprocal exchanges or face-to-face interactions. As noted by Larabee (Larrabee & Bolden, 2001), nursing care is one of the key influencers in patient self-reported outcomes. The environment can impact the nurses' ability to connect with their patient. For example, if the requested items in the space are poorly placed or forces the nurses to put themselves in compromising position.

Having established the concept that spatial layout can allow for greater face-to-face interactions, this research intends to explore how a point of observation in the patient room with no visual co-presence may impact the satisfaction of the patient. Additional work needs to be done to show the relationship of spatial layout, visual interaction, and co-presence to room performance.

For this study, the variable will be measured through identification of the orientation of the clinician at the hand-washing sink and the measured angle of view to the patent's head of bed, called the "location of first encounter.". There are three possible orientations in this study: Facing, back and in the toilet room. An orientation of the staff facing the sink to wash their hands and their ability to view the patient at a 30 degree or less.. The degree angle was identified through the work of West (2013) whom studied the effective angle a head could turn to engage with the subject's gaze. All other angles would be considered as a "back" oriented position. The other category is identified as "in." This position is within the patient's toilet room. It is clear that this is not an acceptable location for hand washing; however, for constancy for the variable, it was noted as a separate category (Figure 3.5). The orientation of the hand wash sink matched the units for most of the instances. It is thought that the rooms with handwash sinks facing the patient would be considered higher performing rooms. Not included in this study but something that could be considered as an additional variable would be the location of hand sanitizer gel. It was observed that many of the rooms had additional hand sanitizing gel in the room, however this was not the primary mode of cleansing the hands throughout the Emory campus.

Figure 3-5 Spatial variable, Location of first encounter is measured by the angle of view from the patient hand wash sink in three categories (facing, back, in)



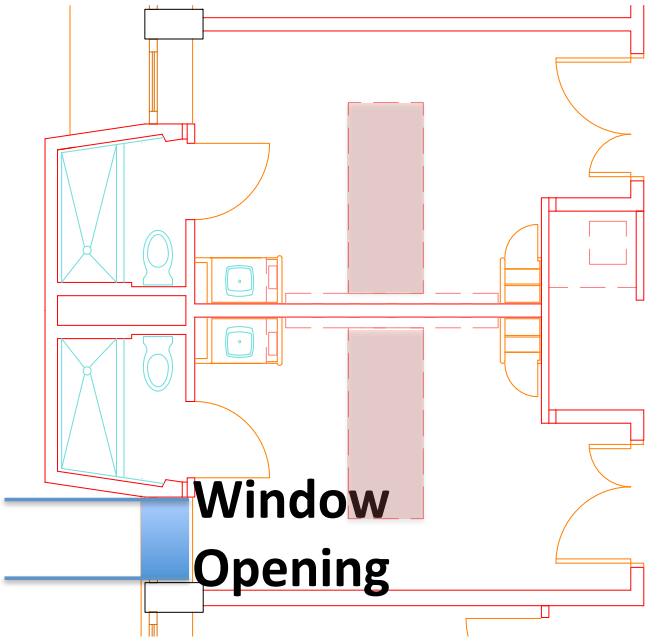
3.1.5. Window opening

The window is an essential component in a patient's room. The influence of a window on patient outcomes was one of the first architectural studies that was demonstrated in Ulrich's seminal work (Ulrich, 1984), in which he identified that the view out the window in a surgical unit improved recovery where the views were to green spaces and higher pain was recorded in rooms with a view to a brick wall. While in this study the view of the room was not identified, the length of the window opening was noted as a variable. While visiting the campus and reviewing the rooms, it was noted as an urban campus where many of the windows had little view to nature. Within the sample that was selected for the study, the number was so few that the variable was moved to focus on the window opening. It could be argued that when a person is in bed the view is to the sky and not to the ground. Therefore, the length of window area could impact the amount of natural light that would enter the room, which has also been shown to improve overall patient demeanor and wellbeing.

For this study the linear dimension of the window opening will be taken as the interior of the fixed wall surface (Figure 3.6). The frame width and depth vary, so the frame will not be included in the length of the window opening. There are three categorical variables for the window opening small (less than 5 lineal feet), medium (5 to 10 lineal feet) and large (11 lineal feet and larger). These categories were created by a relatively equal distribution by unit of

rooms with various window types. It was thought that this study would show that rooms with the larger opening would have higher outcomes. There are opportunities to create additional variables to explore window impact on outcomes with an inclusion of views from the patient bed.

Figure 3-6 Spatial variable, window opening is measured by the lineal length of the external window of the patient room in three categories (small, medium, large)



3.1.6. Room and unit survey predictor variable

Table 3-2 General and Preliminary study population distribution by room and unit

		Measures	Single Corridor (B) north	Single Corridor (B) south	Double Loaded Corridor (G)	Triangular (E)	Total
survey distribution by room	Preliminary	number of total beds	16	16	24		56
	General	number of total beds	32	32	122	140	326
	Preliminary	Room types	16	16	24		56
	General	Room types	17	16	24	24	81
	Preliminary	number of units/ floors in the study	1	1	1		3
	General	number of units/ floors in the study	2	2	6	6	16
	Preliminary	number of total surveys by Unit	829	766	2,155		3,750
	General	number of total surveys by Unit	502	597	2,100	1,416	4,615

The preliminary study included five years (January 1st, 2008 to December 31st 2012) worth of data with a limited Disease Related Group (DRG) and two specified units, cardiac medical and cardiac surgical patients, at Emory University Hospital. Preliminary population of 56 rooms come from the B and the G units at EUH and contains 3,750 patient surveys, of which 2,155 surveys come from the G unit (Table 3.2). The unit of analysis for the present study is the individual survey, as it is important to have the ability to individually explore the possible relationship of the survey and the other possible influencing variables.

The general population data request included all discharges from the hospital from July 2012 to June 2014. This two year study includes surveys from three units in the facility of 326 rooms that included all medical and surgical patients. ICU and clinical trial units were not included in the study. A total of 81 room types were identified in the 16 units in the study with about 1,300 surveys per unit, with overall 4,615 surveys in the study (Table 3.2).

3.2. Moderating variables

3.2.1. Identification of patient characteristic variables that influence satisfaction

Much research has been done to identify what factors influence patient self-reported outcomes. In particular, research has been done to see if there is a predisposition of a patient to be satisfied with the experience. As previously described, patient experience is a person's perception of service quality versus what they feel as though they have received. There are factors of patient types that show similar outcomes. These determinates of satisfaction are shown to influence the satisfaction outcomes. They are: age (Rosenheck, Wilson, & Meterko, 1997; Williams & Calnan, 1991), gender (Hall Judith A., 1990; Williams & Calnan, 1991), education (Bertolino & Mainous, 1993), socio-economic status (Carlson, Blustein, Fiorentino, & Prestianni, 2000), and admission through Emergency Department . Additionally, how a patient rates their own health and mental abilities is a key indicator of satisfaction outcomes. (Zapka et al., 1995).

In this study, each survey was received with the unit and room coded data associated with it.. The identifying patient information contained in the data linked to the patient record of gender and age. These variables were categorized for further analysis, shown in Table 3.3. Categories were created for each individual variable. This included age (18-34, 35-49, 50-64, 65-79 and 80+), gender (male and female), and admission type (Emergency and general). For the emergency department, admission data was included in the preliminary study from the EUH system, whereas in the general study it was provided through the HCAHPS question, and the author used that data and created numeric categories as noted above. The HCAHPS questions that were included related to the patient's self-assessment of health in the general population study as an additional determinate of satisfaction. While self-assessment of health has been noted as an influencer of patient outcomes (Zapka et al., 1995), it was not something that was received for both study populations, so it was not included in the moderators for both studies. Based on the need to have complete comparable data, three key moderators were chosen as determinates of satisfaction. The purpose of this study was to demonstrate the relationship between satisfaction and spatial variables, not to conduct an exhaustive analysis to define why. All the patient demographic information was not included in the study such as socio-economic status and education level as the intent of the work is to demonstrate a relationship while also confirming a relationship with patient demographics. It is not intended to be an exhaustive analysis of every possible variable. These additional variables could be included in further studies to refine why. The other moderators could be used in further explorations or studies.

Table 3-3 Patient characteristics categorical variable for this research study

Study Variable	Type	Measure	Data source
patient characteristic			
Age	predictor	5 categorical (18-34, 35-49, 50-64, 65-79 and 80+)	EUH-Press Ganey
Gender	predictor	2 categorical (male and female)	EUH-Press Ganey
Emergency Department Admit	predictor	3 categorical (Ed admit, not)	EUH-Press Ganey
HCAHPS			
Admitted through Emergency Room	Moderator	2 categorical (yes-no-no answer)	EUH-Press Ganey
Rate overall health	Moderator	5 categorical (excellent-poor)	EUH-Press Ganey
Rate mental or emotional health	Moderator	5 categorical (excellent-poor)	EUH-Press Ganey

3.2.2. The role of nursing care

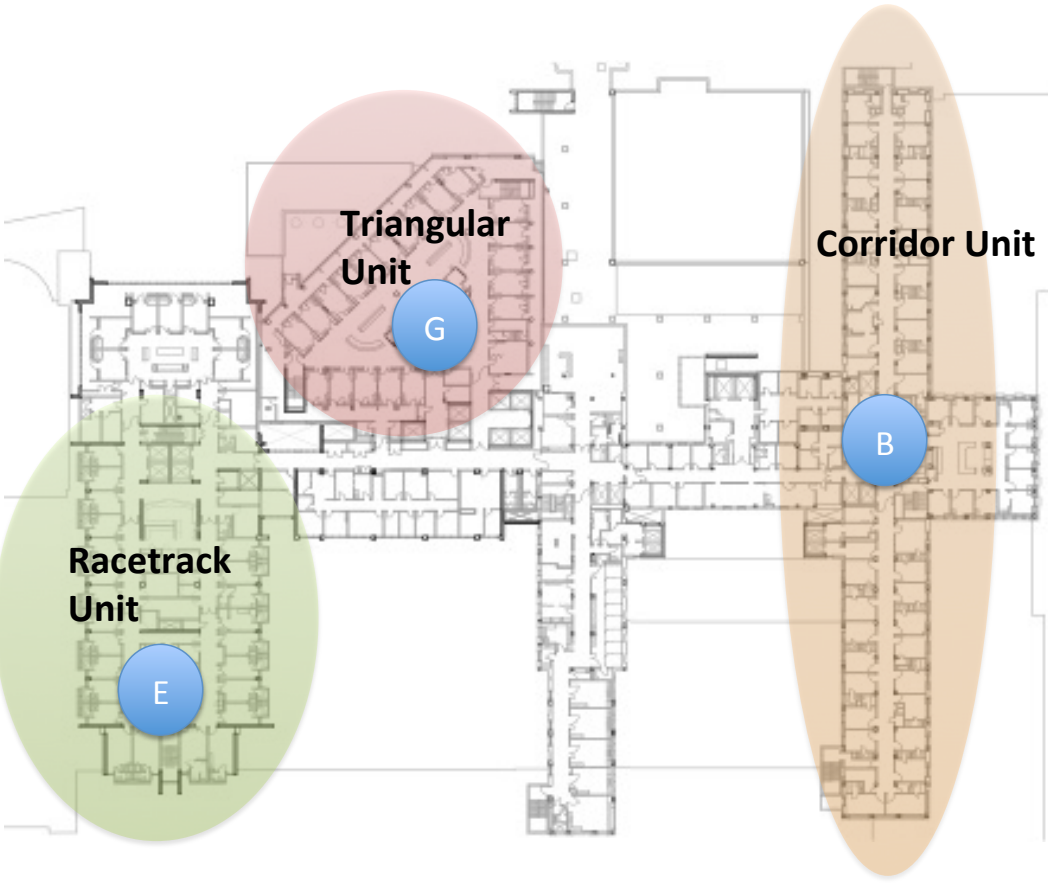
Nursing care is the process of restoring malfunctioning bodies to health through the provision of "instrumental" and "affect" care (Watson, 2002). Nursing care has a major influence on patient self-reported outcome, due to the amount of time nurses spend with patients during the course of a hospital stay (Leiter, 1998). Instrumental care involves the physical treatment of symptoms and has been the subject of quality of care and other process improvement efforts. Affect care is defined as behaviors that are considered expressions of care in the psychological model (Watson, 2002). This type of care is more relational and represents authentic connections between care provider and patient. This study focuses on the nurses and physician relationship in their role in caring for the patient in the patient room and how it is reflected in the patient's experience of care at those critical points. Therefore, the focus in this study is on the inpatient unit at Emory University Hospital.

3.2.3. Identification of study setting and organizational culture

The study setting is a 579-bed tertiary care, academic medical center in the Southern United States. Medical specialties provided on the campus include cardiology, cardiac surgery, orthopedics, oncology, neurology, neurosurgery, and multiple organ and tissue transplant. Inpatient nursing units within the larger medical center were the focus of the research, as they are

the setting in which patients spend the majority of their time and on which they base their satisfaction assessment. There are three unit types in this study (Figure 3.7). As noted in Cai and Tatton-Brown (Cai, 2012; Tatton-Brown & James, 1987) the layout of a nursing unit can influence the organizational culture even within the same organization. Cai (Cai, 2012) further demonstrated that the location of the nurse's station in the unit layout can be an influence on staff behavior and communication. This study's sample includes three different unit types and three room types that have been defined using the work of both Cai and Tatton-Brown,.

Figure 3-7 Study setting by units at Emory University Hospital for both field studies. There are three unit types: Corridor (B), Racetrack (G), and Triangular (E).



Corridor unit type: The B unit of two floors are included in the study (Figure 3.8 and 3.9). There are two wings, or sides, to the unit, each containing 16 beds with a central nursing station at the end of the hall. These patient rooms have toilet rooms that are at the foot board of the

room. This means that the toilets do not impact the exterior window opening or the view to the hallway – the room is an exact rectangle. These rooms are defined as having nested or mid-board toilets.

Figure 3-8 Corridor unit (B) study setting at Emory University hospital typical room layout and identified spatial variables

a. Room size: 152.6 SF mean size
b. Window opening: 3 feet 6 inches wide
c. Room Handedness: Right or Left
d. Location of first encounter: 2, 3
e. Location of door to head of patient: 2

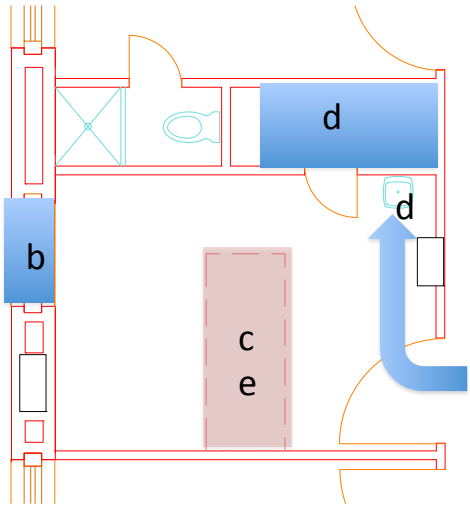
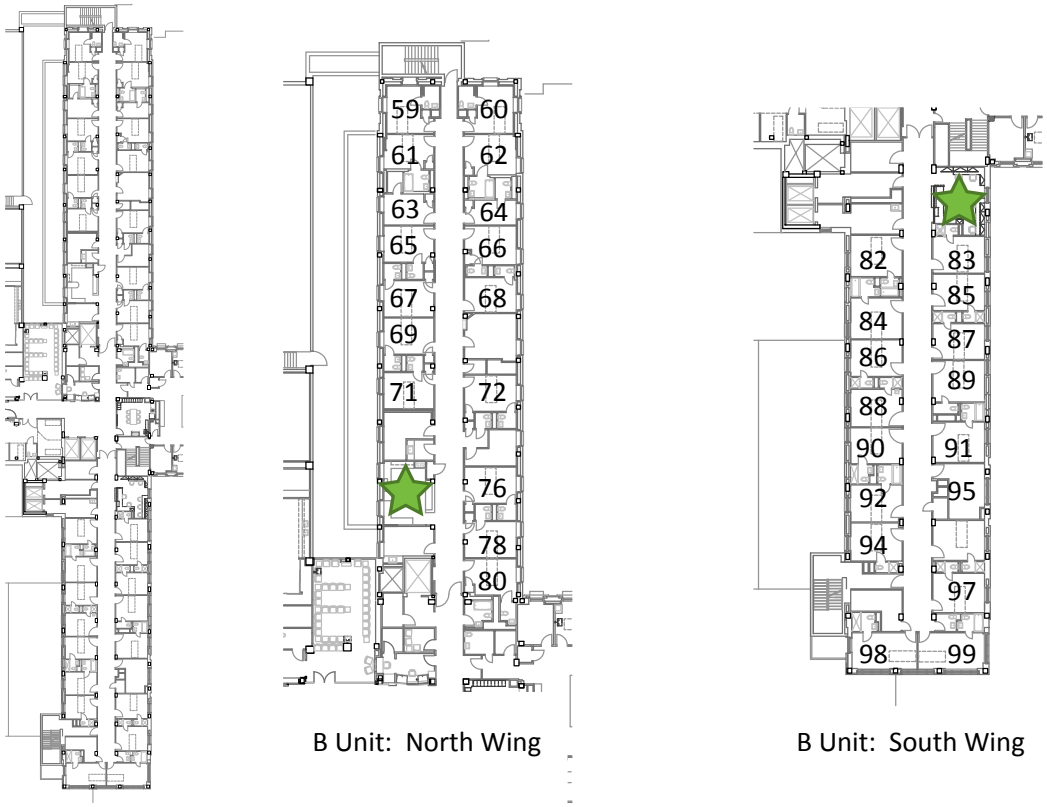


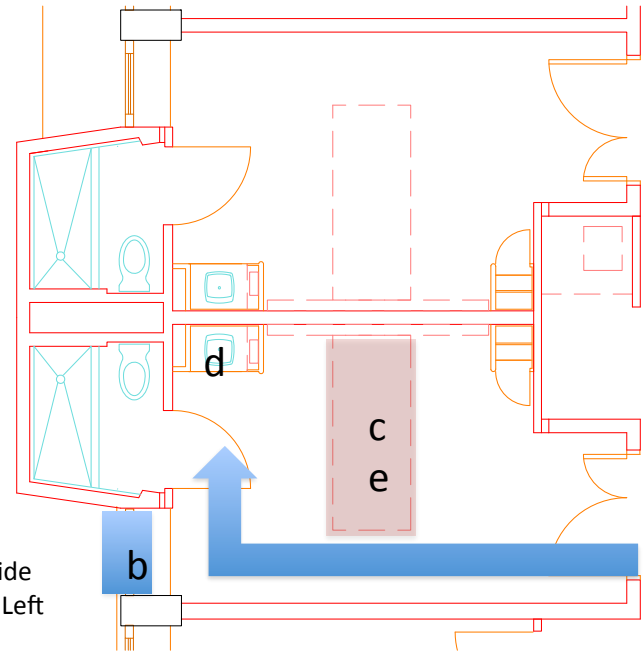
Figure 3-9 Corridor unit (B) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.



Racetrack, or double loaded corridor, unit type (Figure 3.10-3.11): The Emory University Hospital's E unit is a racetrack unit type with 23 patient rooms that are placed in a rectangular shape, while the center of the unit is support and the central nurse's station. The general

population in this study includes six floors of this unit type and is not included in the preliminary model. The room layout is an inboard toilet and allows for the largest of the window openings.

Figure 3-10 Racetrack unit (G) study setting at Emory University hospital typical room layout and identified spatial variables



a. Room size: 173 SF mean size
b. Window opening: 2 feet 4 inches wide
c. Patient Room handedness. Right or Left
d. Location of first encounter: 1
e. Location of door to head of bed: 1

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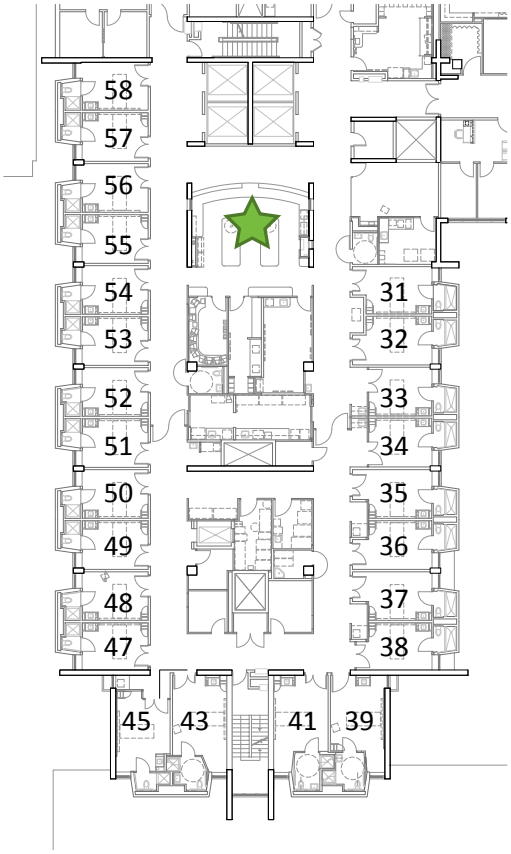
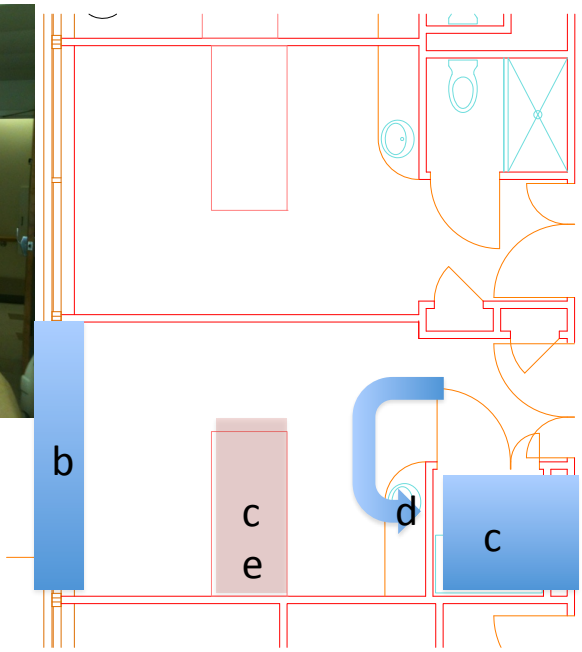
Figure 3-11 Racetrack unit (G) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.



Triangular unit type (Figure 3.12-3.13): At the Emory University Hospital, the G units are the triangular unit type. There are typically 24 beds and have patient rooms on all three sides of the floor and the nurse's station in the center core of the unit. In this study, there are five floors of this type included.

Figure 3-12 Triangular unit (E) study setting at Emory University hospital typical room layout and identified spatial variables.



a. Room size: 198.6 SF mean size
b. Window opening: 11 feet 2 inches
c. Toilet room location: Inboard
d. Location of first encounter: 2
e. Location of door to head of patient: 1

Figure 3-13 Triangular unit (E) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.

In summary the three units included in the two field studies represent varied environments each with a central nurses station (Figure 3.4). All rooms are private inpatient rooms with a connected toilet room. Not all rooms have showers in the room. The toilet is different in each unit as well as the amount of corridor area. In general the number of inpatient rooms and floor area is relatively similar in each unit. All of the noted variables provides a excellent study setting with a good variety of environments.

Table 3-4 Inpatient nursing unit architectural features used to define design of the unit.

	Measures	Single Corridor (B) north	Single Corridor (B) south	Double Loaded Corridor (G)	Triangular (E)
Nursing Unit Architecture Features	Total unit area (square foot)	5,900	6,400	12,350	12,300
	Corridor area (square foot)	1,170	1,100	2,750	3,100
	Area per bed (square foot)	369	400	515	535
	Number of Beds on average	16	16	24	23
	Number of nurses station	1	1	1	1
	Location of toilet room	Mid board toilet		Outboard toilet	Inboard toilet
	Type of Unit	Single Corridor		Double Corridor	Triangular

3.3. Patient self-reported outcomes variables

Patient self-reported outcomes were measured using questions from the Press Ganey survey and the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS). Emory University Hospital (EUH) has been working with Press Ganey to individually track patient experience quality while at the hospital. EUH surveys all patients through either electronic mailing (after 2014) or hard mailing (before 2014) no more than 48 hours post-discharge from the facility. Starting in 2012, 100% of the patients were also given the HCAHPS survey questions as well. All surveys were sent and collected by Press Ganey and the surveys are coded to identify the last room the patient had occupied before discharge.

3.3.1. Press Ganey – patient self-reported outcome variable

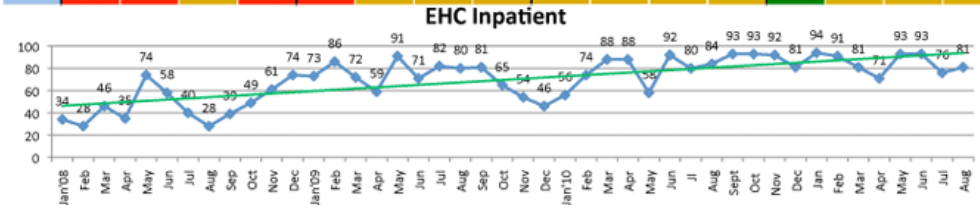
Table 3-5 Press Ganey identified values for the five point Likert-type scale of the survey

	Established values by questions				
	100	75	50	25	0
Press Ganey	very good	good	fair	poor	very poor

The larger Press Ganey survey is comprised of 32 standard questions and six additional questions that further define patients' hospital care experience (see Appendix B for sample survey). All patients at Emory University Hospital (EUH) are provided a survey through the mail a few days after they are discharged from the hospital. In the Press Ganey survey, patients are instructed to use a five-point Likert-type scale to rate their satisfaction with various aspects of the care experience (Table 3.5). The scores provided by Press Ganey reflect a numeric representation of the five response categories: Very poor =0; Poor =25; Fair=50; Good=75; and Very good=100 (table 5). The top box scores include the 'Very Good' (100) responses only. Each question that was answered received a raw score provided directly by the patient to Press Ganey, who created a representational score for the entire hospital and unit over time. Press Ganey then compares the EUH specific score with all of the hospital systems in their database of over 10,000 hospitals and provides a ranking for the hospital where 99 is the highest possible ranking. The overall scores for the EUH campus are shown below over a four year period showing the variation of the overall percentile outcomes (Table 3.6).

Table 3-6 Emory University Hospital trending inpatient data table for the entire hospital from 2008 to 20011 by quarter (source Redge Hanna (MacAllister, Zimring, & Hanna, 2014))

	FY08				FY09				FY10				FY11			
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
Inpatient	40th	38th	51st	42nd	48th	77th	73rd	77th	66th	59th	87th	86th	93rd	87th	82nd	83rd



Data Key
Table Data:
- Red box – ranking below the 50th percentile rank
- Yellow box – ranking between 50th and 89th percentile rank
- Green box – ranking above the 90th percentile rank
- White numbers – ranking above the 90th percentile rank
- Black numbers – ranking below the 25th percentile rank

Graphed Data:
- Trend line – green line
    - Ranks are numerically identified and graphed

The data collected by each patient self-reported outcome score includes the personal characteristics of age, gender, and the room location of the patient at discharge. This information is created by Press Ganey for the purposes of this study and was provided by EUH from a custom data request. Two separate data requests were made for the present study. A unique aspect of the data from the study site is that patient self-reported outcome scores are linked to the last physical space in the hospital the patient occupied prior to discharge, which will be a variable in this study. The patient self-reported outcome scores from Press Ganey have been coded to the room of discharge.

3.3.1.1. Excluded Press Ganey survey questions

Based on the focus of this study on the nursing care unit, the exclusion criteria for the survey data were responses pertaining to other departments or not universal, hospital wide questions. The four areas that were removed from the present study were admitting (A), meals (M), Technician (T), and discharge (D). The author decided that the following 12 questions were omitted from the present study (Table 3.7).

Table 3-7 12 Press Ganey survey question excluded because it was identified as outside the focus are of clinical care delivered in the patient room

Reference code	Question Description
A1	Speed of admission
A2	Courtesy of person admitting
M2	Temperature of the food
M3	Quality of the food
M4	Courtesy of person served food
T1	Wait time for test or treatments
T3	Explanations: happen during Testing &Treatment
T5	Courtesy of person took blood
T7	Courtesy of person started IV
D1	Extent felt ready discharge
D2	Speed of discharge process
D3	Instructions care at home

Along with the above standard questions omitted, the specialized questions that vary by department were also excluded. The questions help to further define the specialty care that the

hospital offers in ICU, organ donation, and transplant care. This study is a campus-wide sampling and the 58 questions were excluded to allow all surveys to have a complete and similar data set (Table 3.8).

Table 3-8 58 Press Ganey survey questions excluded because they covered specialty services and were not universally give to all patients.

Reference code	Question Description
A3	Pre-admission process
R6	TV call button etc. worked
M1	Special/restricted diet explained
T2	Concern comfort during T&T
T4	Skill of person took blood
T6	Skill of person started IV
V1	Helpfulness people info desk
V4	Info family re:condition/treatment
D4	Help arranging home care services
ICU1	Friendliness/courtesy ICU nurses
ICU2	ICU nurse help understand T&T/Condition
ICU3	Attention special/personal need ICU
ICU5	Skill of ICU/CCU nurses
I10	Staff concern introduce themselves
N30	Nurse sensitive/responsive to pain
I15	Patient confidentiality protected
O6	Choose hosp future medical care
ICU13	Rating of the ICU
I44	Staff sensitivity to your needs
I56	Dr/Nurses talked about pain
I75	Extent staff wore ID badges
I76	Extent informed about meds received
I92	Staff wash their hands before exam
I137	Explanation of any delays
I141	Safety you felt with medicines
I172	Family able to participate decision
I173	Staff explained roles in care
I174	Staff supported family throughout
I175	Staff respected having family with
I176	Staff respected cultural/spiritual
TR1	Transplant care: Clinic reception
TR2	Transplant care: Finance Counselor
TR3	Transplant care: Social Worker
TR4	Transplant care: Trans. Coordinator
TR5	Transplant care: Trans. Physician
TR6	Transplant care: Transplant Surgeon
TR7	Transplant care: Psychologist
TR8	Transplant care: Pat Resource Manger
TR9	Transplant care: Nutritionist
TR10	Transplant care: Pharmacist
TR11	Transplant care: Chaplain
TR12	Transplant team worked together
TR13	Respect caring by transplant team
TC1	How well transplant team listened
TC2	Communication between doctors
TC3	Responsiveness of transplant team
TC4	Timeliness of response to concerns
TE1	Transplant team explained issues
TE2	Costs of tnsplnt medicine explained
TE3	Other transplant costs explained
TE4	Plans for f/u care after discharge
TE5	Importance of meds after transplant
TE6	Helpfulness education: medications
TE7	Helpfulness education: diet
TE8	Helpfulness education: incision care
TE9	Helpfulness education: blood work
TE10	Helpfulness education: when to call
TE11	Helpfulness education: how to contact

3.3.1.2. Selected Press Ganey survey questions

Information such as room of discharge, unit, etc. will be included in the data provided from the EUH customized Press Ganey data request. There are 26 questions remaining to be included in the present study, covering six separate areas: room aesthetics (R), nursing care (N), visitor accommodations (V), physician care (P), individual needs (I), and overall assessment (O). The detailed questions are listed below as a full list of all included questions (Table 3.9-3.10). The 18 questions listed below are the core patient self-reported outcome variables that are included in both the preliminary and the general population study (Table 3.9). The additional eight questions are included in the general population study only as the data received for these eight questions in the preliminary data set were not complete and the author excluded these questions as a part of the exclusion criteria of questions that were not answered by more than half of the respondents (Table 3.10).

The data base had a developed coding system to track all results based on an alpha and numeric number (for example R1). These codes were referenced to the data table provided by EUH staff. EUH uses both standard and customized questions for their Press Ganey patient self-reported outcome data. All data was received through EUH from Press Ganey with no patient identification information. All scores were received in a numeric listing as noted above Very poor =0; Poor =25; Fair=50; Good=75; and Very good=100. Both the preliminary and general population studies had access to all of the same questions and the same numeric Likert-type scale. When the information was received, all the variables were reviewed for accuracy. All surveys were included in this study, even if the respondent only answered one question. It is important to maintain all responses to accurately represent the sample population. Any survey question that was left blank received a 0 value.

Table 3-9 18 Press Ganey survey question included in both field studies

Reference code	Question Description
R4	Room temperature
R5	Noise level in and around room
N1	Friendliness/courtesy of the nurses
N2	Promptness response to call
N3	Nurses' attitude toward requests
N4	Attention to special/personal needs
N5	Nurses kept you informed
N6	Skill of the nurses
V2	Accommodations & comfort visitors
P2	Physician concern questions/worries
P4	Friendliness/courtesy of physician
P5	Skill of physician
I1	Staff concern for your privacy
I3	How well your pain was controlled
I4	Staff addressed emotional needs
I5	Response concerns/complaints
O3	Likelihood recommending hospital
O4	Overall rating of care given

Table 3-10 8 Press Ganey survey questions included in the general field studies that were not received for the preliminary field study

Reference code	Question Description
R1	Pleasantness of room decor
R2	Room cleanliness
R3	Courtesy of person cleaning room
V3	Staff attitude toward visitors
P1	Time physician spent with you
P3	Physician kept you informed
I6	Staff include decisions re:trtmnt
O2	Staff worked together care for you

3.3.2. HCAHPS – patient self-reported outcome variable

The HCAHPS survey data includes the standard 32 questions (see Appendix A). All patients at EUH, beginning in 2012, were provided a survey asking for their response. For the general population, the survey included the HCAHPS survey questions with the Press Ganey survey, so the patient only had one survey to complete. This provides a very comprehensive

record of all patient reported outcomes. All survey questions are linked to the room of discharge and are integrated with the entire Press Ganey data set. The questions have either a Likert-type scale of 1-4, yes or no, or categorical. Each question received an alpha and numeric code, so that is easy to track (for example: CMS_1). The author recoded all the questions to correspond to the standard survey and gave each question a code that corresponds to the actual survey question (for example: HCAHPS_1). It was noted, as the information was reviewed, that some questions that had many categories, such as ethicality, and were broken into individual sections for clearer comparisons (Table 3.11).

Table 3-11 Established values for both the Press Ganey and HCAHPS surveys and the relationship established for each score. This study is focused only on the highlighted 100 column defined as "top box"

Established values by question reference

	100	75	50	25	0
Press Ganey	very good	good	fair	poor	very poor
HCAHPS_1-9, 11,13, 14,16, 17	always	sometimes	usually	never	no answer
HCAHPS_22	definitely yes	probably yes	probably no	definitely no	no answer
HCAHPS_23,24,25	strongly agree	agree	disagree	strongly disagree	no answer
HCAHPS_27, 28	excellent	very good	good	fair	poor

There are eight sections to the survey that include: your care from nurses, your care from doctors, the hospital environment, your experience in this hospital, when you left the hospital, overall rating of the hospital, understanding your care when you left the hospital, and about you. All sections have at least one question included in the study.

3.3.2.1. Excluded HCAHPS survey questions

Upon review of the questions, similar exclusion criteria were identified for the Press Ganey survey: the questions that pertained to discharge and questions related to patient need for toileting or medication. The questions that remained in the study were things that the staff could have improved such as controlling pain. The other survey questions that were excluded were

further patient characteristics. While the author felt that this may be helpful to further explore the possible influencers in the results, because this information is not known for the entire population, they were removed from the study. These included education level, race, and language. The self-report of health status remained in the study questions but will be independently explored in the final chapter of this study. A full list of the excluded questions is noted below in Table 3.12.

Table 3-12 18 HCAHPS survey questions excluded from primary and general field studies based on unnecessary patient information, toileting and medication distribution. CMS 34 and 13 were excluded as it did not follow a five point Likert-type scale

Reference code		Question Description
CMS_12	HCAHPS_10	Need help bathroom/using bedpan
CMS_13	HCAHPS_11	Help toileting soon as you wanted
CMS_14	HCAHPS_12	Need medicine for pain
CMS_18	HCAHPS_15	Given medicine not taken before
CMS_33	HCAHPS_16	Tell you what new medicine was for
CMS_19	HCAHPS_17	Staff describe medicine side effect
CMS_20	HCAHPS_18	Left hospital- destination
CMS_21	HCAHPS_19	Staff talk about help when you left
CMS_22	HCAHPS_20	Information regarding symptoms/problems to look for
CMS_27	HCAHPS_29	Highest grade or school completed
CMS_28	HCAHPS_30	Spanish, Hispanic or Latino
CMS_29A	HCAHPS_31	Race-White
CMS_29B	HCAHPS_31	Race-Black or African American
CMS_29C	HCAHPS_31	Race-Asian
CMS_29D	HCAHPS_31	Race-Hawaiian or Pacific Islander
CMS_29E	HCAHPS_31	Race-Ameri Indian Alaska Native
CMS_30	HCAHPS_32	Language mainly speak at home
CMS_34	HCAHPS_ 4	Never pressed call button

3.3.2.2. Included HCAHPS survey questions

There were a total of 20 questions that remained in the present study for analysis. The specific questions are noted in Table 3.13 below for further reference.

Table 3-13 20 HCAHPS survey questions included in the general field study based on criteria that the activities occur in the inpatient room

Reference code		Question Description
CMS_1	HCAHPS_ 1	Nurses treat with courtesy/respect
CMS_2	HCAHPS_2	Nurses listen carefully to you
CMS_3	HCAHPS_3	Nurses explained in way you understand
CMS_37	HCAHPS_ 4	Call button help soon as wanted it
CMS_6	HCAHPS_5	Doctors treat with courtesy/respect
CMS_7	HCAHPS_6	Doctors listen carefully to you
CMS_8	HCAHPS_7	Doctors explained in way you understand
CMS_10	HCAHPS_8	Cleanliness of hospital environment
CMS_11	HCAHPS_9	Quietness of hospital environment
CMS_15	HCAHPS_13	Pain well controlled
CMS_16	HCAHPS_14	Staff do everything help with pain
CMS_23	HCAHPS_21	Rate hospital 0-10
HOSEXPER	HCAHPS_21new	Rate entire hospital experience 1-10
CMS_24	HCAHPS_22	Recommend the hospital
CMS_38	HCAHPS_23	Hosp staff took pref into account
CMS_39	HCAHPS_24	Good understanding managing health
CMS_40	HCAHPS_25	Understood purpose of taking meds
CMS_41	HCAHPS_26	Admitted through Emergency Room
CMS_25	HCAHPS_27	Rate overall health
CMS_26	HCAHPS_28	Rate mental or emotional health

The selected survey questions noted above have Likert-type scale responses, except for question 26 which is a yes/no question. When the data was received from EUH, all HCAHPS data that was received had written and not numeric responses. The Table 3.14 created below to provide a corresponding value to the response that would match the values provided to the Press Ganey question sets. Each response in the entire survey sessions was recoded with the corresponding numeric value (Table 3.14). Please note any survey that was left blank received a 0 value. There are a total of 43 questions, each with categorical responses.

Table 3-14 Full list of all selected and identified patient self reported outcome study variables from both Press Ganey and HCAHPS (General study only).

Reference code	Study Variable	Type	Measure	Data source
	Patient self reported outcome			
	Press Ganey			
R1	Pleasantness of room decor	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
R2	Room cleanliness	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
R3	Courtesy of person cleaning room	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
R4	Room temperature	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
R5	Noise level in and around room	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
N1	Friendliness/courtesy of the nurses	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
N2	Promptness response to call	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
N3	Nurses' attitude toward requests	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
N4	Attention to special/personal needs	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
N5	Nurses kept you informed	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
N6	Skill of the nurses	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
V2	Accommodations & comfort visitors	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
V3	Staff attitude toward visitors	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
P1	Time physician spent with you	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
P2	Physician concern questions/worries	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
P3	Physician kept you informed	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
P4	Friendliness/courtesy of physician	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
P5	Skill of physician	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
I1	Staff concern for your privacy	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
I3	How well your pain was controlled	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
I4	Staff addressed emotional needs	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
I5	Response concerns/complaints	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
I6	Staff include decisions regarding treatment	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
O2	Staff worked together care for you	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
O3	Likelihood recommending hospital	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
O4	Overall rating of care given	outcome	5 categorical (Very poor-Very good)	EUH-Press Ganey
	HCAHPS (General Population Only)			
CMS_1	Nurses treat with courtesy/respect	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_2	Nurses listen carefully to you	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_3	Nurses explained in way you understand	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_37	Call button help soon as wanted it	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_6	Doctors treat with courtesy/respect	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_7	Doctors listen carefully to you	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_8	Doctors explained in way you understand	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_10	Cleanliness of hospital environment	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_11	Quietness of hospital environment	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_15	Pain well controlled	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_16	Staff do everything help with pain	outcome	4 categorical (never- always)	EUH-Press Ganey
CMS_23	Rate hospital 0-10	outcome	11 categorical (Different rating 0-10)	EUH-Press Ganey
HOSEXPER	Rate entire hospital experience 1-10	outcome	11 categorical (Different rating 0-10)	EUH-Press Ganey
CMS_24	Recommend the hospital	outcome	4 categorical (def yes-def no)	EUH-Press Ganey
CMS_38	Hosp staff took pref into account	outcome	4 categorical (strong agree- strong dis)	EUH-Press Ganey
CMS_39	Good understanding managing health	outcome	4 categorical (strong agree- strong dis)	EUH-Press Ganey
CMS_40	Understood purpose of taking meds	outcome	4 categorical (strong agree- strong dis)	EUH-Press Ganey

4. Analysis method

Chapter Four reviews the method of analyses and further explores the possible relationship of the variables noted in Chapter Three. As was stated previously, the main goal of this study is to explore the relationship room layout has on patient self-reported outcomes.

4.1. Analysis method overview

This research is an exploratory study looking at the possible relationship between room layout and spatial features and patient self-reported outcomes. The overarching question for this study is to explore if room layout and / or spatial features impact a patient's experience of care. In studies of the physical environment, there are many variables that can be influencers on the intended outcome (Berg, 2001; Cai, 2012; Choi, 2011; Hagerman et al., 2005; Y. Lu, 2011; Y. Lu et al., 2014; Pati et al., 2010; Rashid et al., 2006; Ulrich, 1984). In the present study, each identified variable will be analyzed to see if there is a logical relationship between the variables. This study is organized via a series of questions to test the relationships of the variables and the two sample populations. The rationale for these specific selected questions was discussed in Chapter Two. The questions move from an exploration of the data by type and then systematically analyzing the data to see the possible relationship between each variable group: Patient characteristics, spatial variable and patient satisfaction .

The systematic method of data analyses test the variables and their relationship by exploring all the possible influencers, in turn showing all possible moderating relationships that could exist in the study. The questions listed above will be used for each study setting and followed in the same order, to explore the multi-variable environment of a hospital setting and its influencers.

The sample population is explored and tested for possible relationships with moderating variables such as rooms, units, or patient characteristics. Once these tests are complete, the exploration of the relationship of spatial variables and patient self-reported outcomes is studied. Moving through a series of data analysis techniques allows for a full understanding of the relationships to the samples.

All variables were defined in detail in Chapter Three. For the purpose of this study, each variable is identified as a predictor, moderator, or outcome, and the category, along with the source of the data, is identified (table 3 and 14). As has been noted before, doing rigorous research of the influences of built environment is very difficult (Devlin & Arneill, 2003). Utilizing a multiple method and multiple variable method of analysis is intended to investigate all know plausible influencers, as in the study of the environment it is hard to isolate variables without influencing the occupant.

4.2. Normality

To begin, each of the raw full likert-type scale data set was tested to see if the dependent variable, individual patient survey questions, was normally distributed. The goal of the study was to have at least 30 surveys per room which pushed the sample size for each data set to over 3,500 (Preliminary N=3,751 and General N=4,615). With each sample size over 3,500, a simple normality test using Shapiro-Wilks could not be used for such a large sample population. Instead, visual histogram graphics were used to show normality of the outcome variables. Additionally, the skewness and kurtosis values were recorded.

SPSS was used to generate the visual histogram plots. The plots were selected to show a normal curve(see Appendix C and D for full data, selected plots shown in Figure 4.1). The skewness and kurtosis values were also identified and recorded (Table 4.1-4.2). After the data was initially tested for normality with the full Likert-type scale, and the skewness and kurtosis values were recorded, it was clear that the dependent variable was not evenly distributed.

The data set was then re-coded as a binary data set instead of the given Likert-type scale. The highest possible score, a value of 100, was coded as a 1 (top box) and the remaining score values were coded as 2 (non-top box) (Table 3.11). This is representational of what the service quality industry strives to achieve. The highest possible single score, known as “Top Box,” is a primary indicator for the overall measures of patient satisfaction (Jha, Orav, Zheng, &

Epstein, 2008) and therefore is the primary indicator for this study. This recoded "Top Box" data set was retested for normality. As is found with binary categorical variables the outcome showed a normally distributed outcome. The histogram with the normality curve shows a normal distribution and acceptable skewness and kurtosis values (Table 4.2) (see Appendix C and D for full data).

Figure 4-1 Sampling of normality plots for the general field study population using fully distributed five point Likert-type scale

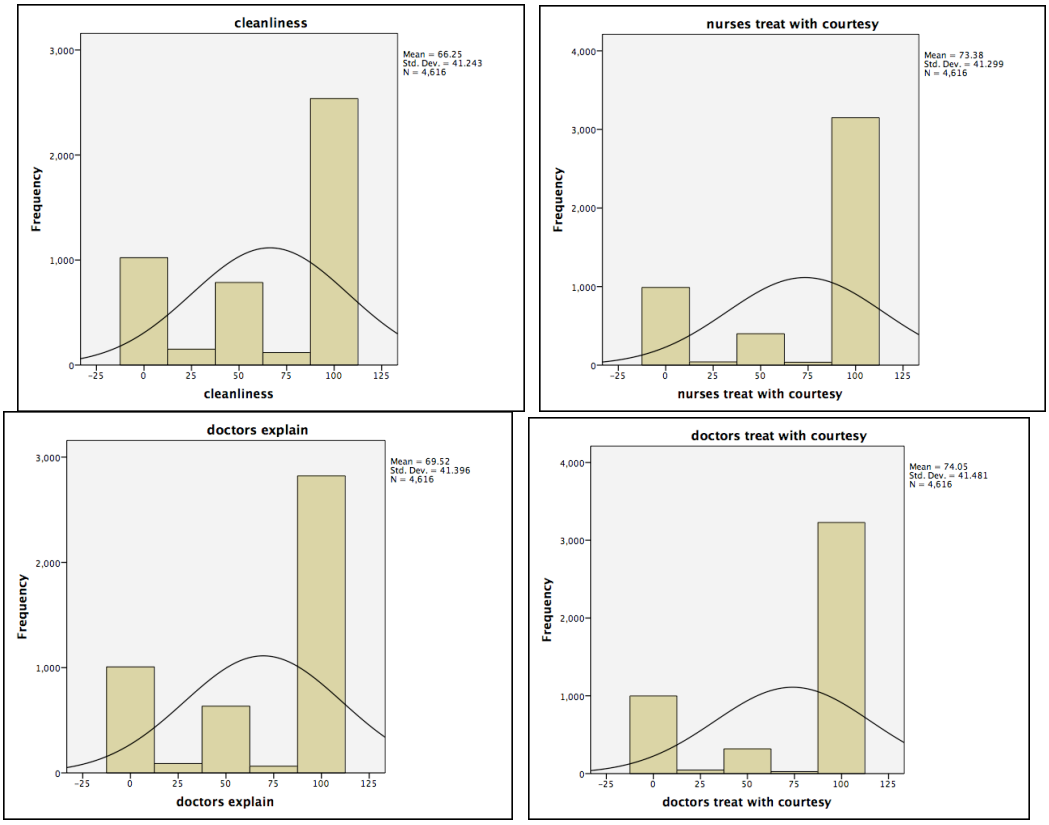


Figure 4-2 Sampling of normality plots for the general field study population using "top box" binary variable

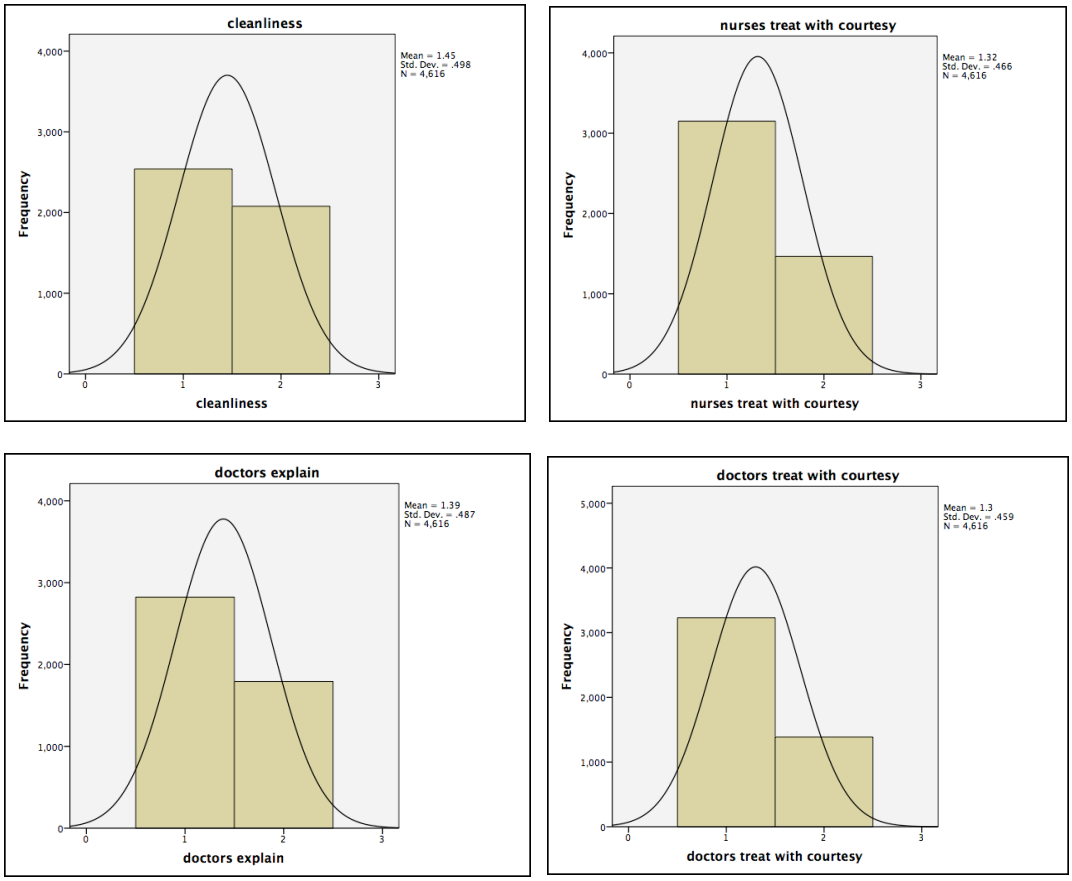


Table 4-1 Normality test of the preliminary population with the fully distributed Likert-type survey results identifying the Skewness and Kurtosis values

Statistics	Valid	Missing	Skewness	TOP BOX skewness	Std. Error of Skewness	Kurtosis	TOP BOX Kurtosis	Std. Error of Kurtosis
Sat Room: Room Temperature	3751	0	-1.383	0.646	0.04	0.558	-1.583	0.08
Sat Personal Issues: Noise level in and around the room	3751	0	-1.571	1.215	0.04	0.935	-0.524	0.08
Sat Nurses: Friendliness/ Courtesy of the Nurses	3751	0	-1.535	0.187	0.04	1.713	-1.966	0.08
Sat Nurses: Promptness in responding to the call button	3751	0	-0.487	0.861	0.04	-1.516	-1.235	0.08
Sat Nurses: Amount of attention paid to your special or personal needs	3751	0	-1.411	-0.179	0.04	2.047	-1.969	0.08
Sat Nurses: How well the nurses kept you informed	3751	0	-0.956	-0.609	0.04	0.37	-1.629	0.08
Skill of nurse	3751	0	-2.348	0.727	0.04	5.917	-1.472	0.08
accomodation visitors	3751	0	-2.088	0.53	0.04	4.413	-1.72	0.08
Sat Physician: Physician's concern for your questions and worries	3751	0	-2.364	0.91	0.04	5.365	-1.172	0.08
friendliness of Physcian	3751	0	-1.504	0.249	0.04	1.426	-1.939	0.08
skill of physcian	3751	0	-2.049	0.819	0.04	3.341	-1.33	0.08
Sat Personal Issues: Staff concern for your privacy	3751	0	-2.828	1.201	0.04	8.68	-0.557	0.08
Sat Staff sensitivity	3751	0	-3.102	1.835	0.04	9.306	1.366	0.08
pain controlled	3751	0	-2.007	0.493	0.04	4.183	-1.758	0.08
staff addressed emotional needs	3751	0	-1.376	0.078	0.04	1.28	-1.995	0.08
Sat Personal Issues: Response to concerns/ complaints made during your stay	3751	0	-2.099	0.684	0.04	4.208	-1.533	0.08
Sat cheerfulness	3751	0	-2.115	0.572	0.04	4.245	-1.674	0.08
Sat Overall Assessment: Likelihood of your recommending this hospital to others	3751	0	-1.659	0.733	0.04	1.551	-1.463	0.08

Table 4-2 Normality test of the General population with the fully distributed Likert-type survey results identifying the Skewness and Kurtosis values

General Population- Tob box and Actual	Valid	Missing	Skewness	TOP BOX Skewness	Std. Error of Skewness	Kurtosis	TOP BOX Kurtosis	TOP BOX Std. Error of Kurtosis
Rate Hospital	4615	0	-1.086	-0.232	0.036	-0.615	-1.905	0.072
Rate entire hospital	4615	0	-1.952	0.252	0.036	2.5	-1.938	0.072
Recommend the hospital	4615	0	-1.128	0.628	0.036	-0.581	-1.607	0.072
nurses treat with courtesy	4615	0	-1.049	0.784	0.036	-0.72	-1.386	0.072
nurses listen carefully	4615	0	-0.804	0.397	0.036	-1.059	-1.843	0.072
nurses explain	4615	0	-0.792	0.398	0.036	-1.089	-1.843	0.072
call button help soon	4615	0	-0.311	-0.177	0.036	-1.606	-1.97	0.072
doctors treat with courtesy	4615	0	-1.089	0.871	0.036	-0.669	-1.242	0.072
doctors listen carefully	4615	0	-0.926	0.611	0.036	-0.931	-1.628	0.072
doctors explain	4615	0	-0.828	0.458	0.036	-1.051	-1.791	0.072
cleanliness	4615	0	-0.66	0.201	0.036	-1.242	-1.96	0.072
quietness	4615	0	-0.468	-0.124	0.036	-1.335	-1.985	0.072
pain controlled	4615	0	0.004	-0.432	0.036	-1.755	-1.814	0.072
Staff do everything to help	4615	0	-0.156	-0.077	0.036	-1.85	-1.995	0.072
rate overall health	4615	0	0.251	-3.372	0.036	-1.055	9.378	0.072
rate mental health	4615	0	-0.166	-1.352	0.036	-1.429	-0.173	0.072
hospital staff took preference	4615	0	-0.714	-0.51	0.036	-1.173	-1.741	0.072
understanding managing health	4615	0	-0.803	-0.277	0.036	-1.067	-1.924	0.072
understood purpose	4615	0	-0.516	-0.246	0.036	-1.563	-1.94	0.072
pleasantness of room decor	4615	0	-1.309	-0.543	0.036	1.542	-1.705	0.072
Room cleanliness	4615	0	-1.804	0.07	0.036	3.054	-1.996	0.072
courtesy of cleaning person	4615	0	-1.92	0.444	0.036	2.753	-1.804	0.072
room temperature	4615	0	-1.348	-0.358	0.036	1.199	-1.873	0.072
noise level	4615	0	-1.547	0.033	0.036	1.674	-2	0.072
friendliness of Nurse	4615	0	-2.947	1.216	0.036	8.784	-0.521	0.072
promptness response to call	4615	0	-1.881	0.382	0.036	2.74	-1.855	0.072
nurses attitude	4615	0	-2.447	0.852	0.036	5.696	-1.275	0.072
attention to needs	4615	0	-2.22	0.677	0.036	4.39	-1.542	0.072
nurses kept you informed	4615	0	-2.162	0.627	0.036	4.286	-1.608	0.072
skill of nurse	4615	0	-2.521	1.004	0.036	5.783	-0.993	0.072
accomodations visitors	4615	0	-1.497	0.022	0.036	1.418	-2	0.072
staff attitude	4615	0	-2.201	0.67	0.036	4.017	-1.552	0.072
time physician	4615	0	-1.812	0.28	0.036	2.946	-1.922	0.072
physician concern	4615	0	-2.158	0.655	0.036	4.108	-1.572	0.072
physician kept informed	4615	0	-2.035	0.575	0.036	3.581	-1.67	0.072
friendliness of physician	4615	0	-2.605	1.058	0.036	6.331	-0.881	0.072
skill of physician	4615	0	-2.682	1.304	0.036	6.317	-0.301	0.072
staff concern privacy	4615	0	-2.386	0.56	0.036	6.243	-1.687	0.072
pain controlled	4615	0	-1.738	0.338	0.036	1.959	-1.887	0.072
staff addressed emotional needs	4615	0	-1.711	0.225	0.036	1.978	-1.95	0.072
response concerns	4615	0	-1.631	0.265	0.036	1.555	-1.931	0.072
staff include decisions	4615	0	-1.798	0.338	0.036	2.363	-1.887	0.072
staff worked together	4615	0	-2.772	1.095	0.036	8.312	-0.802	0.072
likelihood recommending	4615	0	-2.877	1.362	0.036	8.183	-0.144	0.072
overall rating	4615	0	-2.802	1.235	0.036	7.921	-0.476	0.072

Mylod (Mylod, 2015) supported the approach for seeking normality of the data but further informed that the data. when looked at in aggregate. is not affected by normality and that in most cases the normality in their analysis is ignored because it has been shown to have minimal impact on the statistical analysis. The Likert-type scale has also been argued that it is not an actual Likert – type scale, because the distance between each point is not always equal and there also needs to be clearly two positive and two negative choices and one neutral. Technically, the "fair" question in the Press Ganey data survey could be seen as slightly negative and has been argued as such. The HCAHPS scores are also not Likert-type, as they are not constant in their distribution and do not keep to the positive, negative, and neutral structure, as they only have 4 to 10 levels in their scales. While the ranges are not equal, again researchers have found that the full-scale analysis has more meaning for the hospital, while the top box or binary analysis has greater meaning for the between-hospital comparison. While this discussion clarifies to the author that normality within the patient self-reported outcome analysis is not influential in the possible outcomes, the use of the binary, more normally distributed data could enhance the between-hospital relationships.

This study intends to identify a sample that has a normally distributed outcome variable. The range was established based on the large sample size. The acceptable range of inclusion criteria in this study for skewness is from -.5 to 0.5 and for kurtosis is from -3 to 3. The above noted normality tests were used to reduce the number of survey questions in review for this study. It was concluded that following the recoding of the data to a "top box" dichotomist (or binary) variable, all satisfaction survey questions fell within a normally distributed range. This establishes, for the tests in the following analysis, that the dependent survey question variable is categorical and dichotomist with normal distribution that are mutually exclusive and exhaustive.

4.3. Analysis method- step by step

This retrospective study is a multiple method exploration of the possible relationship that two sample populations have on patient self-reported outcomes, or satisfaction, and spatial layouts. The "**preliminary"** population was selected as a stable patient population, with a clear outcome trajectory, in a nursing care unit that has been stable over the five years that were observed. The second population, "**general,"** was for the entire EUH continuous campus, excluding ICU or other various specialty services. The step-by-step process is reviewed in this section, where each analysis model is set up and all the variables are discussed and reviewed. Each step below will restate the research question and identify: a. type of analysis used, b. variables, and c. rational and the strategy for the analysis. As each step is reviewed, an example of the analysis tool will be shared from the initial preliminary study. All statistical analysis was completed using IBM SPSS Statistics version 22 for Macintosh.

The following section details the series of analysis tests. Each section states the research question that is being investigated. The analysis is described, in detail, in Table 4.3 as well as in the written review in point C of each analysis. Point A reviews identifies the independent variable and point B identifies the dependent variable for the study. The purpose of this section is to further establish the methodology and demonstrate the ability to explore the influence of moderating variables in the built environment while revealing a plausible relationship.

Table 4.3: Research study analysis table identifying each step in both field studies.

Research Task	Hypothesis/Research Question	Population	Predictors	Moderators	Controls	Outcomes	Descriptive strategy	Analysis tools	Unit of Analysis	(N)
1a	What are the sample population's characteristics?	Preliminary	patient age, gender, admission type	Same Hospital Campus	DRG, Unit type	number of surveys by room and unit	Is the sample population representative?	Descriptive Statistics: frequencies	Survey	3,751
1b	What are the sample population's characteristics?	General	patient age, gender, admission type	Same Hospital Campus	none	number of surveys by room and unit	Is the sample population representative?	Descriptive Statistics: frequencies	Survey	4,615
2a	Is there a relationship between room of discharge and satisfaction scores?	Preliminary	types of room. Room of discharge.	Same Hospital Campus	DRG, Unit type	all patient reported outcomes, satisfaction questions	Can the satisfaction scores share the same room of discharge?	Logistical Regression Analysis	Survey	3,751
2b	Is there a relationship between room of discharge and satisfaction scores?	General	room of discharge. Clustered rooms by types	Same Hospital Campus	none	all patient reported outcomes, satisfaction questions	Can the satisfaction scores share the same room of discharge?	Logistical Regression Analysis	Survey	4,615
3a	Is there a reason for the room performance (number of top box scores on average in the room of discharge during the study period)?	Preliminary	types of room. Room of discharge.	Same Hospital Campus	DRG, Unit type	amount of visualization, room score performance	to define the best and the worst rooms and that there is variation by unit	Visual map	Room	56
3b	Is there a reason for the room performance (number of top box scores on average in the room of discharge during the study period)?	General	room of discharge. Clustered rooms by types	Same Hospital Campus	none	amount of visualization, room score performance	to define the best and the worst rooms and that there is variation by unit	Visual map	Room	81
4a	Are satisfaction questions correlated within the room of discharge? Are all answers always the same result?	Preliminary	overall satisfaction	Same Hospital Campus	DRG, Unit type	satisfaction promptness	do the scores have a relationship to each other?	Scatter plot coefficient of determination	Survey	3,751
4b	Are satisfaction questions correlated within the room of discharge? Are all answers always the same result?	General	overall satisfaction	Same Hospital Campus	none	satisfaction promptness	do the scores have a relationship to each other?	Scatter plot coefficient of determination	Survey	4,615
5a	Are the patients assigned to rooms randomly?	Preliminary	patient characteristics (gender, age, and admission type)	Same Hospital Campus, room assignments by acuity	DRG, Unit type	room of discharge	Is there a relationship? Between patient characteristics and room of discharge?	Chi-squared	Survey	3,751
5b	Are the patients assigned to rooms randomly?	General	patient characteristics (gender, age, and admission type)	Same Hospital Campus, room assignments by acuity	none	room of discharge	Is there a relationship? Between patient characteristics and room of discharge?	Chi-squared	Survey	4,615

Table 4.3: Research study analysis table identifying each step in both field studies.

Research Task	Hypothesis/Research Question	Population	Predictors	Moderators	Controls	Outcomes	Descriptive strategy	Analysis tools	Unit of Analysis	(N)
6a	Are patient satisfaction scores tied to the patient characteristics?	Preliminary	patient characteristics (gender, age, and admission type)	Same Hospital Campus, room assignments by acuity	DRG, Unit type	all patient reported outcomes, satisfaction questions that had a relationship to room of discharge	Is there a relationship? Between patient characteristics and satisfaction scores?	Logistical Regression Analysis	Survey	3,751
6b	Are patient satisfaction scores tied to the patient characteristics?	General	patient characteristics (gender, age, and admission type)	Same Hospital Campus, room assignments by acuity	none	all patient reported outcomes, satisfaction questions	Is there a relationship? Between patient characteristics and satisfaction scores?	Logistical Regression Analysis	Survey	4,615
7a	What is the sample population by room and unit categorical spatial variable?	Preliminary	patient age, gender, admission type	Same Hospital Campus	DRG, Unit type	room and unit characteristics	Is the sample population representative?	Descriptive Statistics: bar chart, side by side box plot	Survey	3,750
7b	What is the sample population by room and unit categorical spatial variable?	General	patient age, gender, admission type	Same Hospital Campus	none	room and unit characteristics	Is the sample population representative?	Descriptive Statistics: bar chart, side by side box plot	Survey	4,615
8a	Are satisfaction scores tied to the categorical spatial variable?	Preliminary	room layout characteristics 5 (distance to the rn station, visibility, location of first encounter, orientation of bed, bed location)	Same Hospital Campus, room assignments by acuity	DRG, Unit type	all patient reported outcomes, satisfaction questions that had a relationship to room of discharge	Is there a relationship? Between room characteristics and overall satisfaction scores?	Logistical Regression Analysis	Survey	3,751
8b	Are satisfaction scores tied to the categorical spatial variable?	General	room layout characteristics 5 (distance to the rn station, visibility, location of first encounter, orientation of bed, bed location)	Same Hospital Campus, room assignments by acuity	none	all patient reported outcomes, satisfaction questions that had a relationship to room of discharge	Is there a relationship? Between room characteristics and overall satisfaction scores?	Logistical Regression Analysis	Survey	4,615
9a	What is categorical spatial variable performance (number of top box scores in that room during the study period)?	Preliminary	room layout characteristics that was significant (distance to the rn station, visibility, location of first encounter, orientation of bed, bed location)	Same Hospital Campus, room assignments by acuity	DRG, Unit type	all patient reported outcomes, satisfaction questions that had a relationship to room of discharge	what is the difference by room variable categorical type and mean satisfaction score?	Descriptive Statistics	Survey	3,751
9b	What is categorical spatial variable performance (number of top box scores in that room during the study period)?	General	room layout characteristics that was significant (distance to the rn station, visibility, location of first encounter, orientation of bed, bed location)	Same Hospital Campus, room assignments by acuity	none	all patient reported outcomes, satisfaction questions that had a relationship to room of discharge	what is the difference by room variable categorical type and mean satisfaction score?	Descriptive Statistics	Survey	4,615

4.3.1. What are the sample population's characteristics?

a. Variable Independent: patient age, gender, admission type,

b. Variable Dependent: patient survey by unit and room

c. Analysis: To further comprehend the population being tested, descriptive statistics – frequencies were used to explore and understand. The goal is to achieve at least 20 - 40 returned surveys per room type. It is also intended to fully understand the sample by room and unit to be sure to note any abnormal distributions of age, gender, and admission type. (Figure 4.3)

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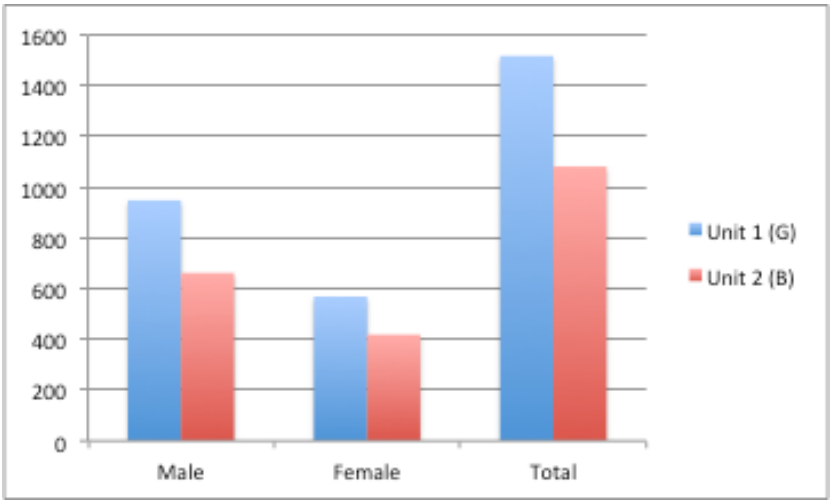
Figure 4-3 Sample descriptive table of patient characteristic for by the binary categorical variable, gender



4.3.2. Is there a relationship between room of discharge and satisfaction scores?

a. Variable Independent: room of discharge (room number)

b. Variable Dependent: each patient self-reported outcome scores (satisfaction) analyzed individually.

c. Analysis: The logistical regression test is a special case of the generalized logistical model that is used when the dependent variable is categorical and

binary. It is selected for this analysis because the dependent variables - the survey responses - were re-coded to categorical, binary variables of "top box" and "non-top-box." Thus, the dependent variables were re-coded from five levels into two, more normally distributed dichotomous variables that are mutually exclusive and exhaustive. The independent variable consists of all rooms in the study. The intent of this test is to see if there is a relationship between the patient self-reported outcome scores to the room of discharge. It is clear that the surveys came from the room, but will there be a direct relationship of the individual scores to the room of discharge? The test of a multiple logistical regression was chosen, as the independent variable has over 40 different types of room layouts (Table 4.4). All questions that do not show significance to the room of discharge, p-value of .05 and above, will be removed from the study variable. The new list of satisfaction questions will be compiled for further analysis. The questions that show a relationship to the room will be identified as the significant satisfaction questions and noted in future tests.

Table 4.4: Sample logistical regression analysis between patient satisfaction and room of discharge.

	Room	
	P Value	R
Dependent Satisfaction Variable		
Rate hospital 0-10	0.00	0.068
Rate entire hospital experience 1-10		
Recommend the hospital	0.00	0.069
Nurses treat with courtesy/respect	0.00	0.074
Nurses listen carefully to you	0.00	0.072
Nurses explained in way you understand	0.00	0.08
Call button help soon as wanted it	0.00	0.086
Doctors treat with courtesy/respect	0.00	0.079
Doctors listen carefully to you	0.00	0.074
Doctors explained in way you understand	0.00	0.091
Cleanliness of hospital environment	0.00	0.062
Quietness of hospital environment	0.00	0.102
Pain well controlled	0.00	0.136
Staff do everything help with pain	0.00	0.15
Rate overall health	0.00	0.1
Rate mental or emotional health	0.00	0.094
Hosp staff took pref into account	0.00	0.063
Good understanding managing health	0.00	0.067
Understood purpose of taking meds	0.00	0.069
Pleasantness of room decor	0.00	0.051

4.3.3. Do certain categories or locations of rooms explain better room performance? (number of top box scores on average in the room of discharge during the study period)? Is there a visual pattern of room performance?

a. Variable Independent: types of rooms by room category and sorted by floor.

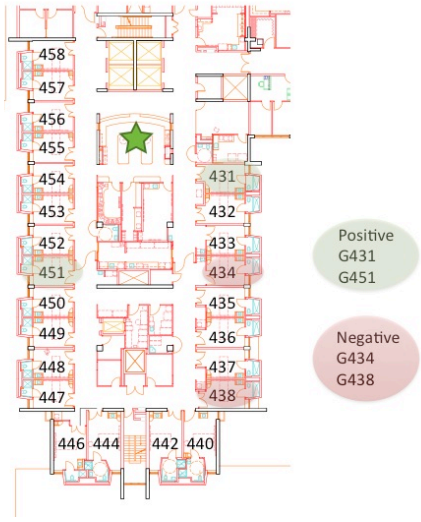
b. Variable Dependent: each patient self-reported outcome scores (satisfaction) analyzed individually.

c. Analysis: Visual maps will be created for each unit type. First, the individual patient survey coded to the room will have a single score that is developed from a question average. All top box answers will be added together and then divided by the number of questions for that data set. This number will make up the room performance from all the surveys that are coded to that room. Then the sum of all surveys by room type will be gathered and then divided by the number of rooms in that room type. Each of the established variables was continuous. It should be noted that in the primary sample set the rooms are all independent, so there are 56 room types. In the general population data set, there are 81 room types for the 326 rooms in the general study. This provides a clustering of like rooms for the purposes of the general study and increasing the n in the sample of rooms tested.

A descriptive analysis was explored to see the frequency of top box scores by room and unit. The score was then ordered by the highest to lowest frequency for top box scores by room and unit. The highest and lowest frequency of top box rooms will be noted on the corresponding floor plan. These unit floor plans review the possible visual patterns, or clear performance relationships, to how the rooms and the unit may be laid out to influence the care environment (Figure 4.4). This exploratory method was used in Choi's analysis of patient falls in the nursing unit and Hsiao and Tan's analysis of room performance (Choi, 2011; Hsiao & Tan, 2011) using a visual dashboard of a floor

plan and scores noted as representative colors from poor performance (no top box scores in the room) to good performance (highest number of beds per room). The room score performance will be compared to the visual syntax map that shows the connectivity of the environment. Could there be a rational to the performance of the room spatially and visually?

Figure 4-4 Sample visual maps that identify room performance for the particular units. Rooms are highlighted as high performing noted in green and low performing room noted in red



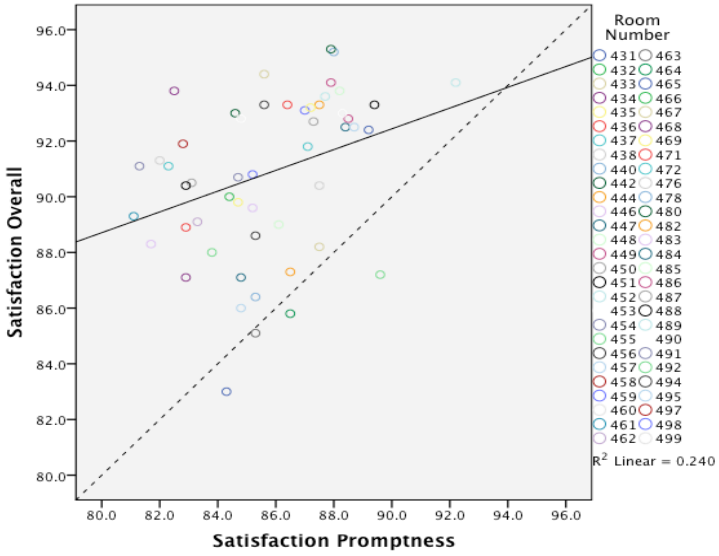
4.3.4. Are the individual satisfaction questions related? Does each question follow the same result?

a. Variable Independent: The individual overall satisfaction scores (binary variable)

b. Variable Dependent: The individual satisfaction scores (binary variable), promptness to respond to the call button.

c. Analysis: Using a scatter plot this study explores the relationship of the room and score difference by room and identified their variance. Report the coefficient of determination (Figure 4.5). Are the room scores universally high or low?

Figure 4-5 Sample score difference between overall satisfaction and promptness satisfaction



4.3.5. Are the patients assigned to rooms randomly? Is there a correlation between room type/number and patient characteristics?

a. Variable Independent: the individual patient characteristics by gender, age, and admission type.

b. Variable Dependent: room of discharge (room number)

Analysis: Is there any relationship to the patient characteristics that are tied to the room they were discharged from? This chi squared test explores the possible impact of staffing assignments of patient characteristics. The chi squared test is selected because each variable is independent with two or more categorical groups. The patient characteristics are binary variables and the rooms are grouped by type.

Table 4.5: Sample Chi squared analysis exploring the relationship of room and patient characteristics for the preliminary field study.

Effect	Chi-Square	df	Sig
Intercept	0.00	0.00	.
ED Admit	105.97	110.00	0.59
Gender	56.19	55.00	0.43
Age	289.85	220.00	0.00

4.3.6. Do patient characteristics completely explain satisfaction scores?

a. Variable Independent: patient age, gender, admission type, (in general study rate of mental health and overall health will be added)

b. Variable Dependent: each patient self-reported outcome scores (satisfaction) analyzed individually.

c. Analysis: This logistical regression study identifies if overall scores could be directly tied to the patient characteristics. Independent variables are the patient characteristics and the dependent variable is the overall satisfaction question (Table 4.6). The spatial variables are each categorical variables and the rooms are grouped by type.

Table 4.6: Sample Logistical regression finding working table that is used to help identify statically significant relationships between patient satisfaction questions and patient characteristics

	Patient Characteristic				
	Admit	Age	Gender	CMS 26 Rate of Mental health	CMS 25 rate of overall health
	P Value	P Value	P Value	P Value	P Value
Dependent Satisfaction Variable					
CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?	0.000			0.000	0.008
CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?	0.000	0.015		0.000	0.023
N 3: Nurses Attitude	0.002	0.044	0.002	0.000	0.03
N 5: Nurses kept you informed	0.003	0.000	0.001	0.000	0.024
R 1 Room: Pleasantness of room décor	0.007			0.000	0.000
R 2 Room: Room Cleanliness			0.001	0.000	0.000
R 4 Room: Room temperature				0.000	0.001
P 4 Physician: Friendliness/courtesy of physician		0.000	0.007	0.000	,018
P 5: Skill of the physician	0.000	0.001	0.000	0.000	0.076

4.3.7. Do room categories and unit types have significantly different patient profiles or patient characteristics?

a. Variable Independent: patient age, gender, admission type

b. Variable Dependent: spatial variables

c. Analysis: This descriptive statistics study explores the frequencies and further defines the sample and identifies the characteristics of the patients being studied in the room (Table 4.7). Was there a relationship of room and patient characteristics? Is there a higher known number of patients in a type of room or is it representational?

Table 4.7: Sample frequency distribution table of the categorical spatial variable by unit

		Total N(%)	Unit B N(%)	Unit G N(%)
Window opening length	small (less than 5 feet)	2155 (57.5)	0 (0)	2155 (57.5)
	medium (5 to 10 feet)	1596 (42.5)	1596 (42.5)	0 (0)
	large (11+ feet)	0 (0)	0 (0)	0 (0)
Distance to the nurses station	Short (1-35 lineal feet)	1024 (27.3)	337 (9)	687 (18.3)
	medium (36-70 lineal feet)	1289 (34.4)	535 (14.3)	754 (20.1)
	long (71+ lineal feet)	1437 (38.3)	723 (19.3)	714 (19)
Point of first encounter	facing	2251 (60)	96 (2.6)	2155 (57.5)
	back	407 (10.9)	407 (10.9)	0 (0)
	in the toiet room	1093 (29.1)	1093 (29.1)	0 (0)
Location of bed	within room	2782 (74.2)	627 (16.7)	2155 (57.5)
	at door	969 (25.8)	969 (25.8)	0 (0)
Oreintation of Bed/ Room handed	Right	1781 (47.5)	744 (19.8)	1037 (27.6)
	Left	1970 (52.5)	852 (22.7)	1118 (29.8)

4.3.8. Are Differences in satisfaction scores are explained by spatial characteristics of the room and unit?

a. Variable Independent: room layout characteristics listed individually

b. Variable Dependent: each patient self-reported outcome scores (satisfaction) analyzed individually.

c. Analysis: This logistical regression study is intended to investigate the relationships of spatial layout and the patient self-reported outcome questions. Can rooms with similar in-room features or spatial configurations be related? (Table 4.8 and 4.9). The logistical regression test is a special case of the generalized logistical model that is used when the dependent variable is categorical and binary. It is selected for this analysis because the dependent variable (the survey responses) was re-coded to categorical, binary variables of "top box" and "non-top-box." Thus, the dependent variables were re-coded from five levels into two, more normally distributed dichotomous variables and are mutually exclusive and exhaustive. The independent variable consists of 4 to 6 categories that are also mutually exclusive and exhaustive. The spatial variables are each categorical variables and the rooms are grouped by type. The spatial variables are each categorical variables and the rooms are grouped by type.

Table 4.8: Sample output of logistical regression analysis of patient satisfaction question and spatial variable

	Room Characteristic				
	Average Distance to RN Station	Room Handed	location of Bed	window	first Encounter
	P Value	P Value	P Value	P Value	P value
Dependent Satisfaction Variable					
CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?				0.008	
CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?				0.009	
N 3: Nurses Attitude	0.035				
N 5: Nurses kept you informed	0.037				
R 1 Room: Pleasantness of room décor	0.045	0.005			0.000
R 2 Room: Room Cleanliness		0.003	0.000		0.010
R 4 Room: Room temperature	0.018	0.019	0.000		0.000
P 4 Physician: Friendliness/courtesy of physician	0.034				
P 5: Skill of the physician					0.001

Table 4.9: Sample working table to further explore the statistically significant results of patient satisfaction question and spatial measures. The table identifies the number of top box scores for each variable and the percent it represents.

	R 1 Room: Pleasantness of room décor						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
first encounter	0.178	0.043	17.355	1	0.000	1.195	0.005
room handed	0.17	0.061	7.75	1	0.005	1.185	0.002
average distance to nurse station	0.080	0.04	4.036	1	0.045	1.084	0.001

4.3.9. What is categorical spatial variable performance? Explore the possible room type performance based on the findings from the analysis (number of top box scores in that room during the study period)?

a. Variable Independent: spatial variable

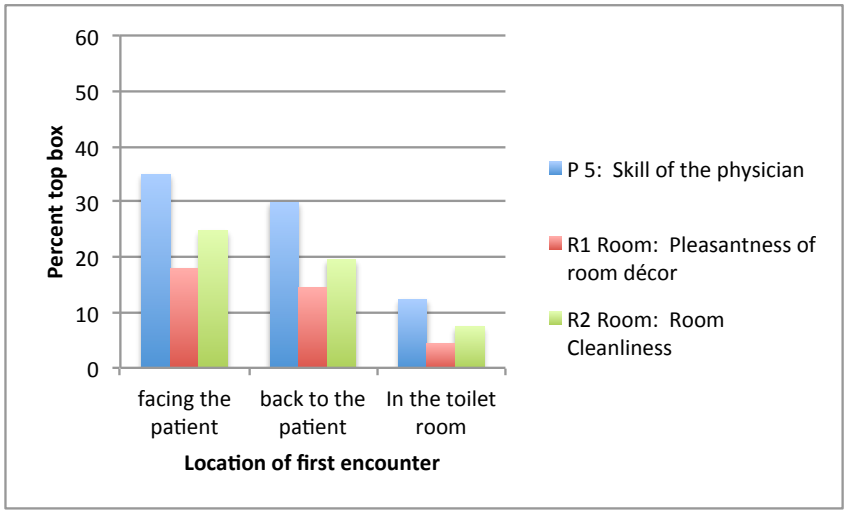
b. Variable Dependent: each patient self-reported outcome scores (satisfaction) analyzed individually.

c. Analysis: Descriptive statistics is used to fully understand the different performance of each survey question by spatial variables (Table 4.10, Figure 4.6). Explore each statistically significant finding to identify what categorical spatial variable was a higher performer. Number of top box surveys and percent of surveys by category.

Table 4.10: Working table of statistically significant results of individual satisfaction questions and one spatial measure spatial variable

	room handed	
	right	left
Dependent Satisfaction Variable	Top Box N(%)	Top Box N(%)
N 1 Nurses: Friendliness/ courtesy of the nurse		
P 1 Physician: physician's concern for your question and worries	1360 (36.3)	1292 (34.4)
P 5 Physician: Skill of Physician	1316 (35.1)	1270 (33.9)
I 1 Staff concern for your privacy		
I 3 Personal Issue: How well was your pain controlled	1188 (31.7)	1136 (30.3)
I 4 Response to concerns/ complaints made during your stay		

Figure 4-6 Sample graphic plot of the percent of top box scores by the spatial variable category. Only statistically significant relationships are plotted.



4.4. Summary of methodology

The mere nature of the study is to explore the possible relationship in the initially established causal model. The intent is not to prove, but to *show* a plausible relationship through rigorous review of the data, while identifying the possible moderating relationships. It is very difficult to truly say that the environment is the main source of a possible outcome, so the findings of this study show an association not a direct cause. The intent of this study is to move logically from the exploration of the room of discharge and the patient self-reported outcome.

Section 2. Field Tests

The next two chapters discuss the two field tests that applies the previous sections preliminary discussion... The intent of these chapters is to have them read as two separate independent studies, smaller preliminary study and a larger general study, following the same logical and rigorous tests. Keeping the studies independent and separate will allow for each study to be explored as separate entities identifying statistically significant relationships between spatial variables and the perception of the patient experience of care.

5. Preliminary study

Patient self-reported outcomes is the outcome variable most closely related to the service quality of an organization. The impact of the environment on allowing inpatient nursing and physician care to be delivered has not been analyzed beyond just the aesthetical value. This study is exploring the plausible relationship between patient self-reported outcome and room layouts, while maintaining awareness of the moderating variables of culture and patient characteristics.

5.1. Methods

A survey analysis of Press Ganey questions concerning patient care in the room were coded to the room of discharge at a tertiary academic medical facility in the southern United States. Five years (3,751) of surveys on two cardiology units were coded to a binary “top box,” normally distributed data set and analyzed through logistical regression to categorical patient and spatial characteristics of the room and unit. The preliminary population included medical and surgical cardiac patients who were discharged from two units at Emory University Hospital from January 1st, 2008 to December 31^{st,} 2012. (Table 5.1).

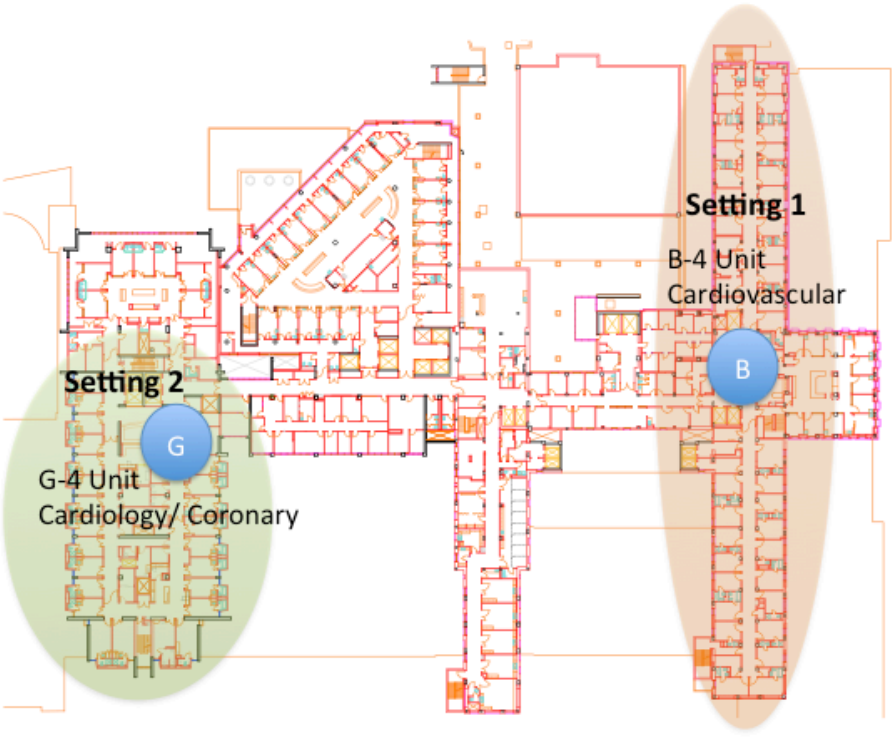
Table 5-1 Preliminary field study population sample size and distribution on the two units

Preliminary Population						
IT UNIT	Unit specialty	NUMBER OF ROOMS	Total Room Types	SURVEYS PER UNIT	Total Surveys per Unit Type	AVG NUMB SURVEY PER ROOM
B4	EUH Cardiology 4B	32	32	1,596	1596	50
G4	EUH Cardiology 4G	24	24	2,155	2155	90
2	**TOTALS**	**56**	**56**	**2 types**	**3751**	**67**

5.2. Setting

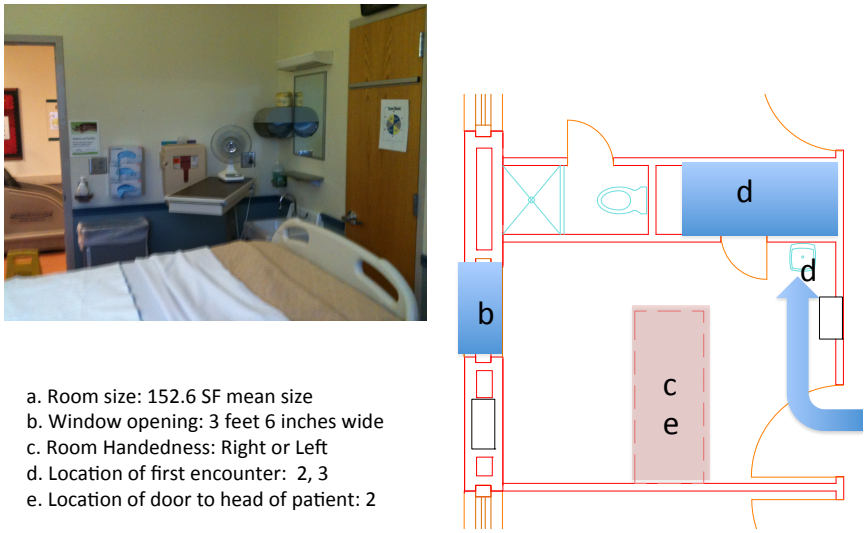
The units have been constant in patient type and practice for over 15 years, providing a very stable, similar sample population. One setting in the study (Unit B) is a single-loaded corridor layout containing 32 rooms; the second setting (Unit G) is laid out in a racetrack configuration and contains 24 rooms, (Figure 5.1) for a total sample of 56 rooms. The unit layouts were categorized using James and Tatton-Brown's (1986) patient unit typology. Both units have a central nurse's station and movable workstations on wheels for electronic management of the patient.

Figure 5-1 Study setting by units at Emory University Hospital for both field studies. There are three unit types: Corridor (B) and Racetrack (G)



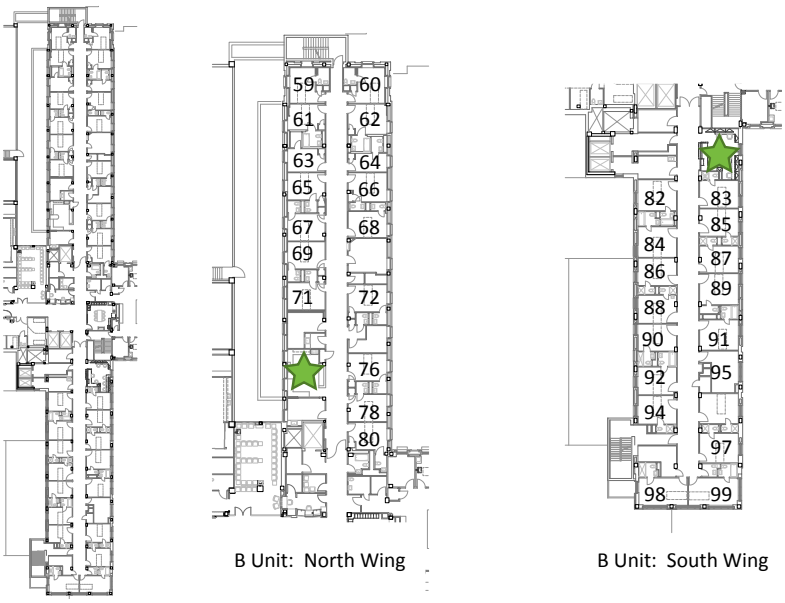
All patient rooms in both units were private and contained a hand wash sink. Unit G had more hand wash sinks at the head of the patients' bed than Unit B. The room sizes were similar: rooms in Unit G were 173 sf.; rooms in Unit B were 153 sf. Most of the patient rooms had toilets and showers: one-half of the rooms in Unit B had no showers. All other physical components of the rooms in both units were similar, including furniture and finishes (Figure 5.2, 5.3, 5.4, 5.5).

Figure 5-2 Corridor unit (B) study setting at Emory University hospital typical room layout and identified spatial variables.



a. Room size: 152.6 SF mean size
b. Window opening: 3 feet 6 inches wide
c. Room Handedness: Right or Left
d. Location of first encounter: 2, 3
e. Location of door to head of patient: 2

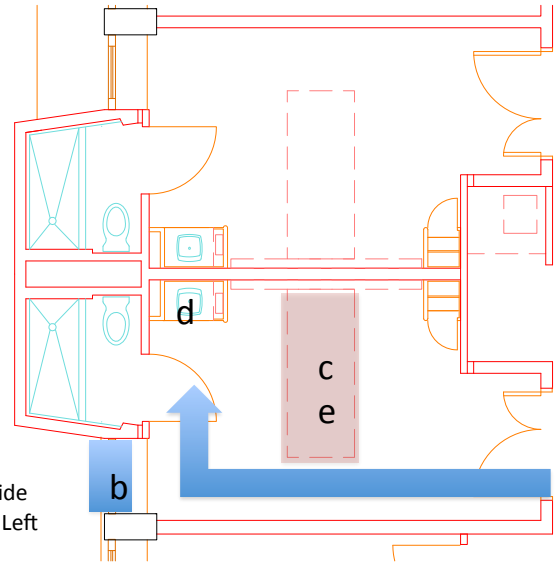
Figure 5-3 Corridor unit (B) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.



B Unit: North Wing

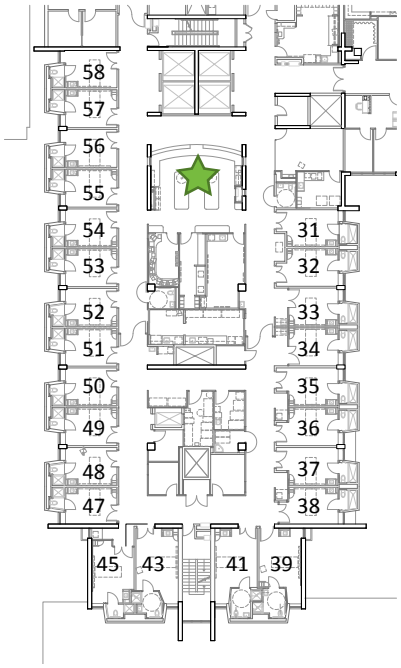
B Unit: South Wing

Figure 5-4 Racetrack unit (G) study setting at Emory University hospital typical room layout and identified spatial variables.



a. Room size: 173 SF mean size
b. Window opening: 2 feet 4 inches wide
c. Patient Room handedness. Right or Left
d. Location of first encounter: 1
e. Location of door to head of bed: 1

Figure 5-5 Racetrack unit (G) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.



5.3. Data Collection

Retrospective patient self-reported outcome data for all rooms (56 total) in cardiology units B and G was collected for a five-year period from January 1st, 2008 to December 31st, 2012. This retrospective sample data was also isolated by a medical based DRG that had the same doctor and care team. This provided a stable sample size with minimal variation. A total of 3,751 patient self-reported outcome surveys were analyzed by room number. Incomplete surveys were coded as "no response" for this research study. A total of 1,596 surveys were returned for Unit B and 2,155 were returned for Unit G. Overall, 67 patient surveys were completed per room (Figure 5.6 and Table 5.2).

Figure 5-6 The distribution of surveys by room of discharge on two units. The mean number of surveys for the study is 67 surveys per room

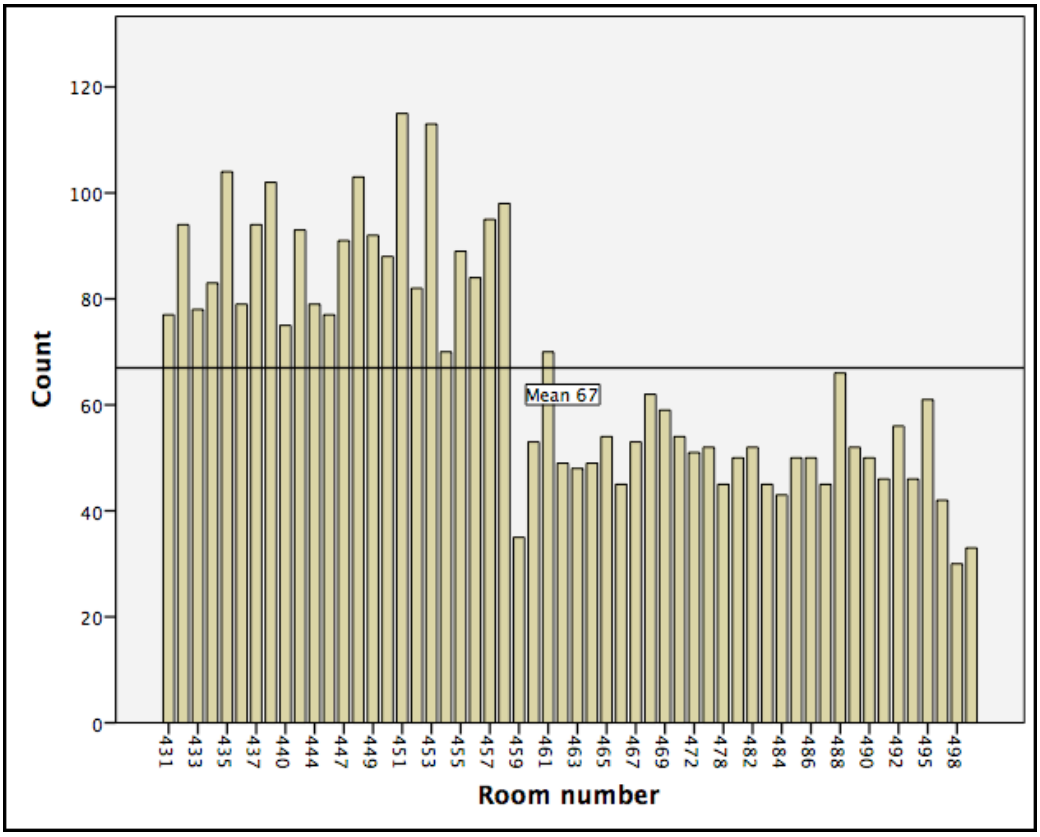


Table 5-2 Frequency distribution of patient surveys by unit

	Frequency	Percent
G Unit	2,155	57.5
B Unit	1,596	42.5
Total	3,751	100.0

5.4. Findings

5.4.1. What is the sample population characteristics?

Descriptive statistics revealed 61.5% (2,307) of the respondents were male and 38.5% (1,444) female. A comparison of the number of surveys returned by gender and unit showed a similar gender ratio, suggesting no gender bias existed in room assignments (Table 5.3 and Figure 5-6, 5.7, 5.8, 5.9). 60% of patients in the sample were between 65 and 79 years of age and there was similar representation in both units. Nearly 40% of the patients (38.9%) were admitted through the emergency department. There were no outliers or inconsistencies with the patient population by unit or in the patient characteristics representative on both units.

Table 5-3 Frequency distribution of patient surveys by patient characteristics categories and sorted into units

		Total N(%)	Unit B- (N)	Unit G- (N)
Age	18-34	130 (3.5)	78	52
	35-49	336 (9)	162	174
	50-64	1024 (27.3)	449	575
	65+	2261 (60.3)	907	1354
Gender	Male	2307 (61.5)	979	1328
	Female	1444 (38.5)	617	827
Admittance	Emergency	192 (5.1)	78	114
	Non Emergency	302 (8.1)	112	190
	Not specified	3257 (86.8)	1298	1959

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Figure 5-7 Frequency graph showing the number of patient surveys by admission type: graph shows total number of respondents in each unit

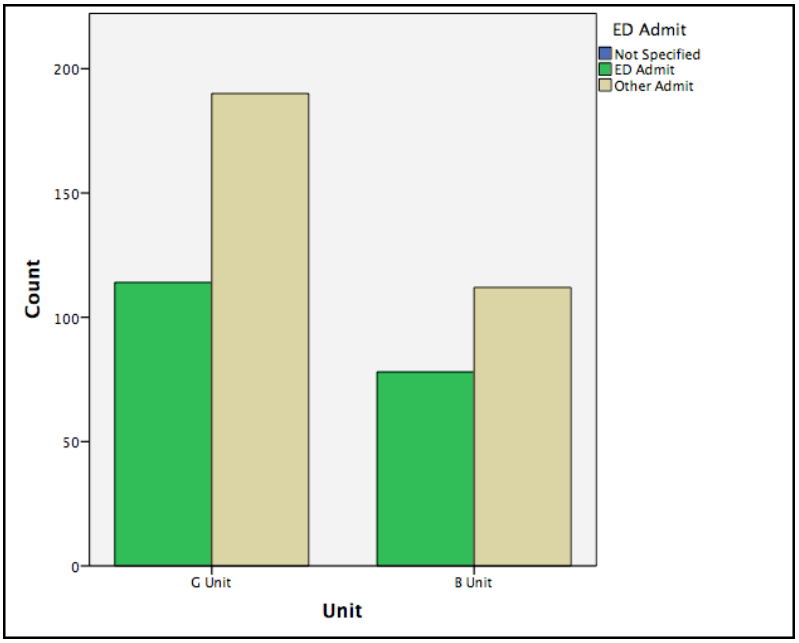


Figure 5-8 Frequency graph showing the number of patient surveys by age category: graph shows total number of respondents in each unit

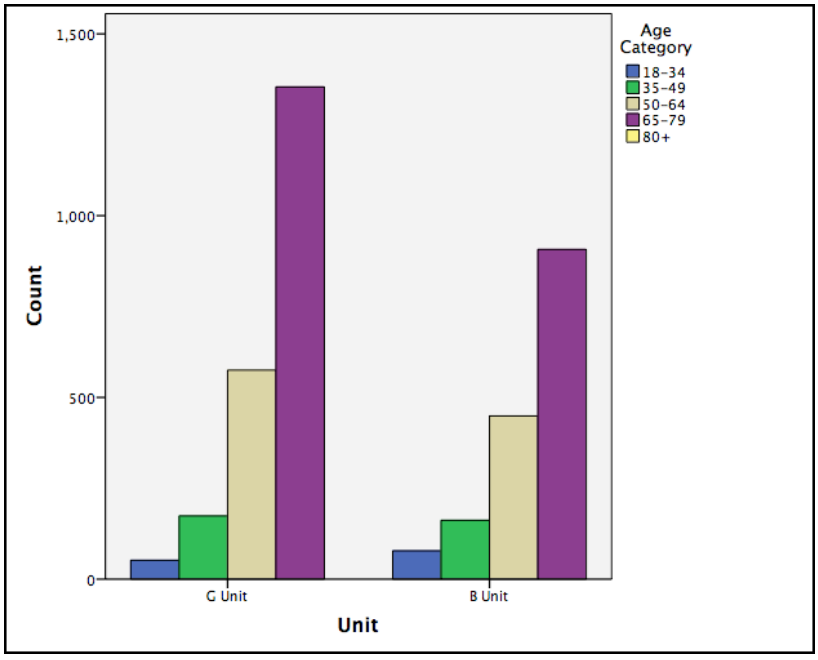
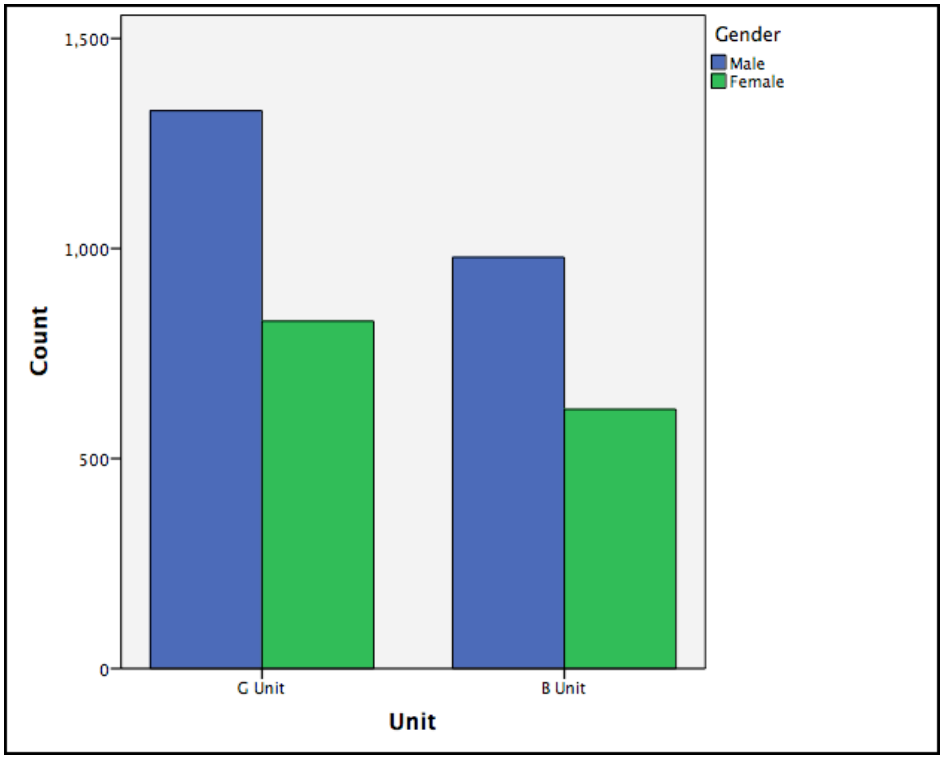


Figure 5-9 Frequency graph showing the number of patient surveys by gender category: graph shows total number of respondents in each unit



5.4.2. Is there a relationship between room of discharge and satisfaction scores?

This initial test sought to determine if there is a plausible relationship between room of discharge and satisfaction survey responses. Through the analysis, there was a clear relationship of individual survey scores tied to the room types. 17 of the 18 survey questions were significantly related to the room of discharge $p<.05$. This result led to follow-up questions like: What was connecting the survey to the room? What created the relationship? With the variation of patient types in the room, and the amount of surveys collected by room, this strong relationship cannot have occurred by chance - there has to be something that is creating that relationship. Could it be that the actual room functions at the same level for each patient?

5.4.3. Do certain categories or locations of rooms explain better room performance? (number of top box scores on average in the room of discharge during the study period)? Is there a visual pattern of room performance?

To investigate the correlation further, a visual map on the actual floor plan was created for the highest and lowest overall average scores of promptness satisfaction to see if there is a visual pattern to explain the variation. Then a new variable was created, which was a mean score by room – the two highest and lowest average scores in each unit were used to set the established levels of performance for that unit.

The G unit is higher performing (10% of top box) than the B unit (4.9% top box). The highest performing rooms corresponded to the unit performance, where all the highest rooms were located in the G unit and the lowest percentage of top box scores were in the B unit (Figure 5.10, 5.11). The highest performing rooms, listed by room number, are (0.5%): 37, 48, 49, 50, 51, 52, 53 and 55. The lowest performing rooms listed by room number, are (0.1%): 59, 60, 62, 64, 72, 80, 83, 84, 86, 87, 88, 92, 97, 98 and 99.

At first glance of the visual map (shown in Figure X) there did not seem to be any obvious patterns or physical indication as to why the room scores were so varied. It was also interesting that, in the B unit, the rooms without any showers had the highest scores. Although this physical component was not a part of this initial study, it may be worth pursuing in future studies related to amenities.

Figure 5-10 Visually map identifying room performance mapped on the floor plan of the B unit. Red indicate negative mean scores for the study and green indicate highest mean score by unit

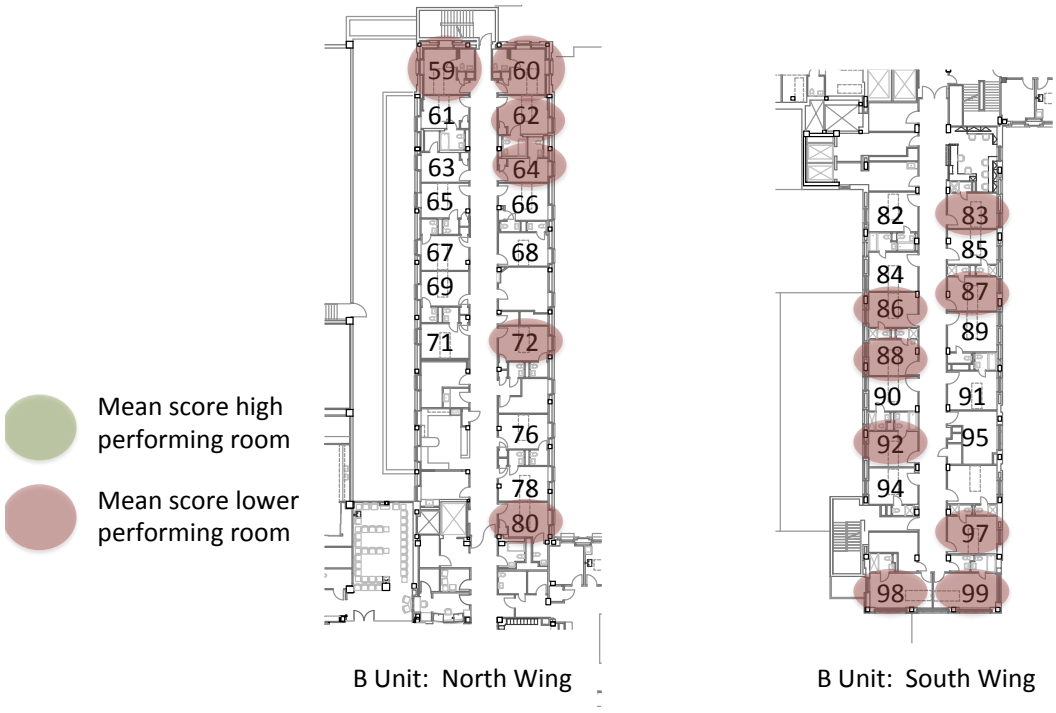
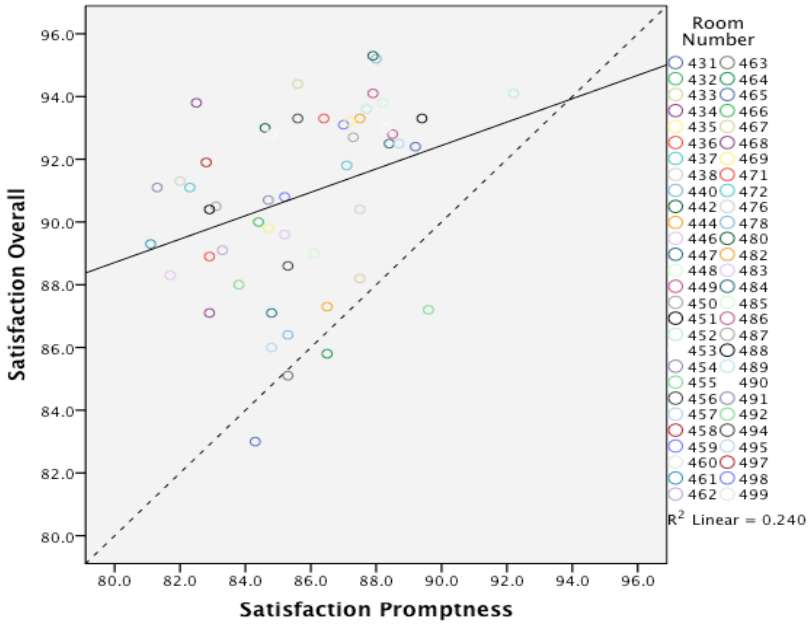


Figure 5-11 Visually map identifying room performance mapped on the floor plan of the G unit. Red indicate negative mean scores for the study and green indicate highest mean score by unit

5.4.4. Are the individual satisfaction questions related? Does each question follow the same result?

The next level of analysis was to see if there was any relationship between individual patient self-reported outcome scores and rooms. Were there rooms that had greater variation between the two patient self-reported outcome scores investigated? This was done through a scatter plot (Figure 5.12). The coefficient of determination is 0.24 for this relationship is found to not be statistically significant. These studies show that there is no relationship between the two scores analyzed. Therefore, each question should be considered an independent variable and is not tied to the other survey questions.

Figure 5-12 Score difference between overall satisfaction and promptness satisfaction



5.4.5. Are the patients assigned to rooms randomly? Is there a correlation between room type/number and patient characteristics?

Could room performance be tied to the type of patient that is assigned a room? Using Pearson's Chi-Squared test to compare patient characteristics to room type, it showed that age, p=.03, could be an influencing factor on the room performance (Table 5.4). This test is looking at the general patient characteristics and not the categorical variables. This is to further define if

there is a relationship. If all older/ younger patients or one-gender patients were assigned to a certain room, this could create a bias.

Table 5-4 Chi squared analysis exploring the overall relationship of room and all patient characteristics for the preliminary field study.

Effect	df	Pearson Chi-Squared Sig
ED Admit	55	.707
Gender	55	.106
Age	165	.03

5.4.6. Do patient characteristics completely explain satisfaction scores?

Are the survey outcomes directly related to the type of patient? This part of the analysis is where we look to the work that has been done previously and suggests that the type of patient can predict the outcome of the survey score (Sitzia & Wood, 1997). The dependent variable is the individual patient self-reported outcome scores for all questions. The independent variable is the individual patient characteristic: gender, age, and admission type. As was found in an earlier test, the age was the only characteristic in this sample that showed a relationship ($p<.05$).

Two categories were created for the variable "admission type:" emergency room or scheduled admission. Emergency admission was identified as the admission type for 192 respondents; 302 respondents reported their admission had been scheduled. If admission type was not identified on the survey, it was assumed that the admission was scheduled (n=3,751).

To further review the correlation of the room, the patient characteristics that have been identified as key possible influencers of satisfaction are gender, age, and admission type. Through logistical regression analysis, the only significant variables that may tie to the room would be gender or age. Logistical regression analysis with expected level of probability, $p<.05$, to show a relationship between room of discharge and patient characteristics. It was found that each survey question score of the patient characteristics were found to be related to every one of the patients characteristics. The results of this study are shared in table 5.16 for the statically significant questions only. In this preliminary study of statistically significant questions one for N!

in regard to patients age was found to be significant. (p-.045). Therefore, we cannot disregard the possible impact the patient age has in this study.

5.4.7. Do room categories and unit types have significantly different patient profiles or patient characteristics?

This section summarizes the distribution of the room spatial characteristics by unit. Within this study, the sample spatial variables included five categorical variables over two units as shown in Table 5.5 The five components of the spatial layout investigated in this exploratory research, and their relationship to patient self-reported outcome, need further study.

Within this two units the spatial variables included five categorical variables : Room handedness, window opening, distance to the nurse's station, location of first encounter, and location of bed which made 56 room types(Table 5.5). The room handedness was equally representative on both units, with 52.5% rooms being left-handed than right. The majority of the beds were located within the room at 74.2%. 60% of the location of first encounter variable is facing the patient, and that is from both units B and G. Back-facing rooms are 10.9 % of B unit only. 38.3% of the rooms were over 70 lineal feet from the nurse's station, making them a long distance. Window opening has little variation between units. Window opening is separated by unit with 57.5% of the rooms having windows less than five feet wide from the G unit only. The lack of variation of the window size by unit was noted and is a concern for the author that it could have a further moderating effect.

Table 5-5 Frequency distribution of returned survey's by categorical spatial variable by unit

		Total N(%)	Unit B N(%)	Unit G N(%)
Window opening length	small (less than 5 feet)	2155 (57.5)	0 (0)	2155 (57.5)
	medium (5 to 10 feet)	1596 (42.5)	1596 (42.5)	0 (0)
	large (11+ feet)	0 (0)	0 (0)	0 (0)
Distance to the nurses station	Short (1-35 lineal feet)	1024 (27.3)	337 (9)	687 (18.3)
	medium (36-70 lineal feet)	1289 (34.4)	535 (14.3)	754 (20.1)
	long (71+ lineal feet)	1437 (38.3)	723 (19.3)	714 (19)
Point of first encounter	facing	2251 (60)	96 (2.6)	2155 (57.5)
	back	407 (10.9)	407 (10.9)	0 (0)
	in the toilet room	1093 (29.1)	1093 (29.1)	0 (0)
Location of bed	within room	2782 (74.2)	627 (16.7)	2155 (57.5)
	at door	969 (25.8)	969 (25.8)	0 (0)
Orientation of Bed/ Room handed	Right	1781 (47.5)	744 (19.8)	1037 (27.6)
	Left	1970 (52.5)	852 (22.7)	1118 (29.8)

5.4.8. Are Differences in satisfaction scores are explained by spatial characteristics of the room and unit?

Logistical regression analysis was conducted to determine if there was a relationship between patient self-reported outcome scores and spatial variables. The independent variables for the analysis were the room's physical characteristics: window opening, distance to the nurse station, room-handedness, bed location, and location of first encounter. While there may be more elements in the room that could have been an influencer to the patient perception of care, it was noted that in this study the focus will be on specific spatial variables that have been shown to influence health outcomes in other studies. The dependent variable was patient self-reported outcome scores for all individual questions on the Press Ganey survey. In the results of the

analysis of spatial variables, six survey questions were a significant predictor of improved outcomes of the number of top box scores.

Table 5-6 Spatial variables and N1 satisfaction question. Relationship identified through Logistical regression analysis *p* <0.05, n=3,751

	N 1 Nurses: Friendliness/ courtesy of the nurse						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
location of first encounter	0.246	0.037	44.536	1	0.00	1.279	0.016

One of the spatial variables (first encounter) was shown to be significantly related to survey question N1: Friendliness and courtesy of the nurse (Table 5.6). More specifically, location of first encounter predicts patient perception of the friendliness and courtesy of the nurse N1 (b=0.246, p<0.05). Through further exploration the location of the hand wash sink to face the patient can likely increase the odds of achieving top box scores on the N1 by 27.9%. The findings show that rooms with a hand wash sink that face the patient are more likely to achieve a top box score in regards to the perception of friendliness and courtesy of the nurse.

Table 5-7 Spatial variables and P1 satisfaction question. Relationship identified through Logistical regression analysis *p* <0.05, n=3,751

	P 1 Physician: physician's concern for your question and worries						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
room handed	0.17	0.072	5.552	1	0.018	1.18	0.002

One of the spatial variables (room handedness) was shown to be significantly related to survey item P1: Physician concern for your question and worries (Table 5.7). More specifically, room handedness predicts patient perception of the physician concern for your questions and worries P1 (b=0.17, p<0.05). Rooms that are oriented to address the patient's right side when a practitioner enters the room can increase the odds of achieving top box scores on the P1 question by 18%.

Table 5-8 Spatial variables and P 5 satisfaction question. Relationship identified through Logistical regression analysis *p* <0.05, n=3,751

	P 5 Physician: Skill of Physician						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
room handed	0.211	0.071	8.859	1	0.003	1.23	0.003

One of the spatial variable of room handedness it was shown to be significantly related to survey item P5: Skill of physician (Table 5.8). More specifically, room handedness predicts patient perception of the physician's skill P5 (b=0.211, p<0.05). Rooms that are oriented to address the patient's right side when the physician enters can increase the odds of achieving top box scores on the P5 question by 23%.

Table 5-9 Spatial variables and I 1 satisfaction question. Relationship identified through Logistical regression analysis *p* <0.05, n=3,751

	I 1 Staff concern for your privacy						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
location of first encounter	0.122	0.042	8.392	1	0.004	1.13	0.003

One of the spatial variables (first encounter) was shown to be significantly related to survey item I1: Staff concern for your privacy (Table 5.9). More specifically, location of first encounter predicts patient perception of the staff concern for your privacy I1 (b=0.122, p<0.05). Location of the hand wash sink to face the patient can increase the odds of achieving top box scores on the I1 question by 13%.

Table 5-10 Spatial variables and I 3 satisfaction question. Relationship identified through Logistical regression analysis *p* <0.05, n=3,751

	I 3 Personal Issue: How well was your pain controlled						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
room handed	0.148	0.067	4.803	1	0.028	1.15	0.002

One of the spatial variables (room handed) was shown to be significantly related to survey item I3: How well was your pain controlled? (Table 5.10). More specifically, room handedness predicts patient perception of how well the pain was controlled I3 (b=0.148, p<0.05).

Rooms that are oriented to address the patient's right side when entering the room can increase the odds of achieving top box scores on the I3 question by 15%. This finding supports that room oriented so that the practitioner is able to get to the right side of the patient as they are trained to attend to the person's right side.

Table 5-11 Spatial variables and I 4 satisfaction question. Relationship identified through Logistical regression analysis *p* <0.05, n=3,751

	I 4 Response to concerns/ complaints made during your stay						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
Window Length	0.231	0.055	17.548	1	0.00	1.26	0.006

One of the spatial variables (window opening) was shown to be significantly related to survey item I4: Response to concerns/complaints (Table 5.11). More specifically, window opening predicts patient perception of the response to complaints during the stay I4 (b=0.231, p<0.05). Rooms that have a smaller window can increase the odds of achieving top box scores on the I4 question by 26%. This finding may be related to the ability to the distractibility that a large window may create as well and providing more daylight. It may be preferred by the patient to have a smaller window that allows staff to focus attention on the patients needs.

Table 5-12 Spatial variables and R 4 satisfaction question. Relationship identified through Logistical regression analysis *p* <0.05, n=3,751

	R4 Room: Room temperature						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
Location of the Bed	-0.227	0.077	8.593	1	0.003	0.797	0.003
Location of First Encounter	0.138	0.038	13.047	1	0	1.148	0.005

Two of the spatial variables (location of the bed and first encounter) was shown to be significantly related to survey item R4: Room temperature (Table 5.12). More specifically, window opening predicts patient perception of the response to complaints during the stay R4 (b=-0.231 to 0.138 p<0.05). Rooms with the head of bed located within the room increase the odds of achieving top box scores on the patient self-reported outcome survey question of room temperature by 21% . Rooms with the orientation of the hand wash sink facing the patient

increases the odds of achieving top box scores on the patient self reported outcomes survey question of room temperature by 15%.

Table 5-13 Spatial variables and P 5 satisfaction question. Relationship identified through Logistical regression analysis $p < 0.05$, n=3,751

	P5: Physician: skill of the physician						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
Location of First Encounter	0.08	0.039	4.169	1	0.041	1.083	0.002

One of the spatial variables (location of first encounter) was shown to be significantly related to survey item P 5: Physician skill of the physician (Table 5.13). More specifically, location of first encounter predicts patient perception of the response to complaints during the stay P5 ($b=0.08$, $p<0.05$). Rooms that have a hand wash sinks oriented to face the patient can increase the odds of achieving top box scores on the P5 by 8%.

To summarize, four of the five spatial variables (window opening, room handedness, location of bed and location of first encounter) were found to directly relate to seven survey questions. However, the other spatial variables (distance to nurse station and bed location) were found to be statistically insignificant in this study.

5.4.9. What is categorical spatial variable performance? Explore the possible room type performance based on the findings from the analysis (number of top box scores in that room during the study period)?

Table 5-14 Percent of top box distribution for spatial variables and satisfaction question relationship identified through Logistical regression analysis *p* <0.05 n=3,751

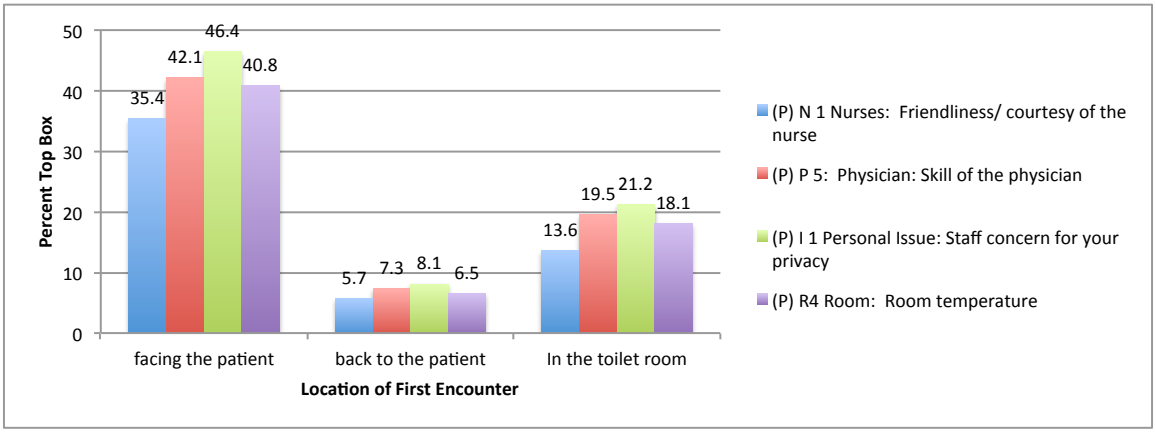
	room handed		location of first encounter		
	right	left	facing	back	in room
Dependent Satisfaction Variable	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)
N 1 Nurses: Friendliness/ courtesy of the nurse			1326 (35.4)	213 (5.7)	511 (13.6)
P 1 Physician: physician's concern for your question and worries	1360 (36.3)	1292 (34.4)			
P 5 Physician: Skill of Physician	1316 (35.1)	1270 (33.9)	1581 (42.1)	274 (7.3)	731 (19.5)
I 1 Staff concern for your privacy			1742 (46.4)	302 (8.1)	797 (21.2)
I 3 Personal Issue: How well was your pain controlled	1188 (31.7)	1136 (30.3)			
R 4 Room: Room temperature			1530 (40.8)	243 (6.5)	679 (18.1)

Table 5-15 Percent of top box distribution for spatial variables and satisfaction question relationship identified through Logistical regression analysis *p* <0.05 n=3,751

	location of bed		window length		
	in room	at door	Small	medium	Large
Dependent Satisfaction Variable	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)
I 4 Response to concerns/ complaints made during your stay			1493 (39.8)	988 (26.3)	0 (0)
R 4 Room: Room temperature	1856 (49.5)	596 (15.9)			

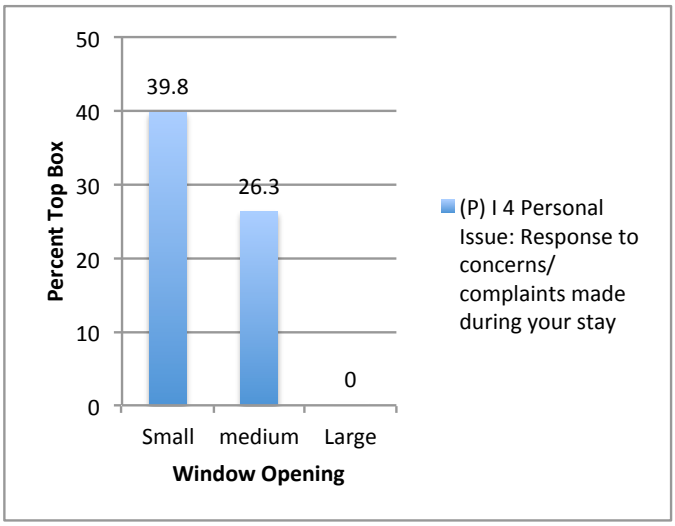
By further exploring the six survey questions that showed a direct relationship to spatial variables, this section of the study looks more closely at the performance variation by characteristic and question as a whole to see what the possible impact is in this identified relationship (Table 5.14 and 5.15).

Figure 5-13 Percent of top box distribution for location of first encounter and satisfaction question relationship identified through Logistical regression analysis *p* <.05, n=3,751



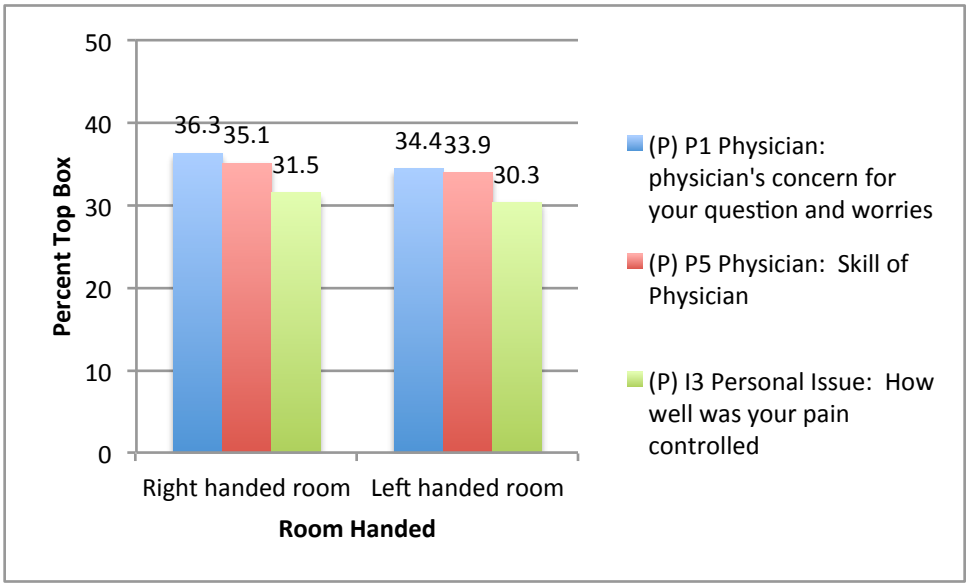
Location of first encounter had two question that was tied to the question N1 and I1 (Friendliness/courtesy of the nurse and Staff concern for your privacy) shown in Figure 5.13. The variation between the rooms with hand wash sinks facing the patient and the rooms with hand wash sinks in the toilet room is 21.8% different. This effect, as was noted before, could be influenced by the sample populations direct relationship to the distribution of the hand wash sink by unit. The distribution of this special variable falls to specific units and could be a factor of the organizational culture.

Figure 5-14 Percent of top box distribution for window opening and satisfaction question relationship identified through Logistical regression analysis *p* <0.05, n=3,751



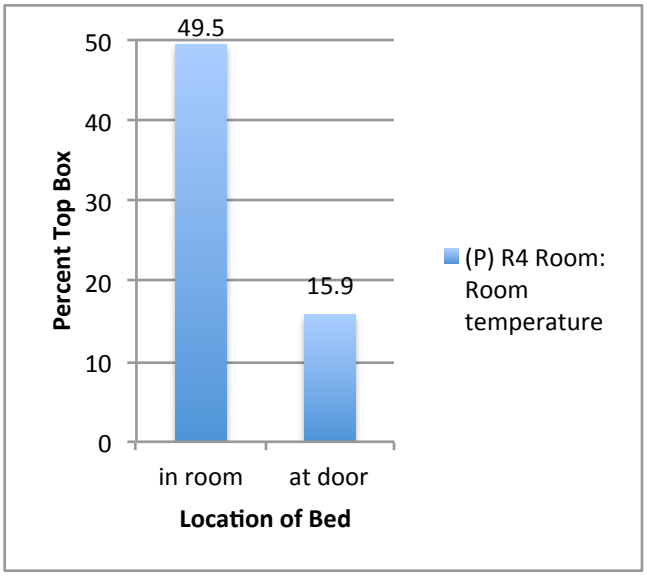
The window size variable has a similar effect on organizational culture where I4 (Response to concerns/complaints made during your stay) is tied to the smaller window size by 13% (Figure 5.14).

Figure 5-15 Percent of top box distribution for room handed and satisfaction question relationship identified through Logistical regression analysis p <0.05, n=3,751



The final spatial variable that was the most evenly distributed sample by units is room handedness. Through the regression analysis, this variable is tied to three survey questions: P2 (Physician: physician's concern for your question and worries), I3 (Personal Issue: How well was your pain controlled), and P5 (Physician: Skill of Physician) (Figure 5.15). The difference between the two variables is smaller, between 1.2 to 1.9% change. The relationship demonstrates that there is a possible relationship of room layout and personal interaction of staff to a patient.

Figure 5-16 Percent of top box distribution for location of bed and satisfaction question relationship identified through Logistical regression analysis $p < 0.05$, n=3,751



The final spatial variable that was location of the bed in the room. Through the regression analysis, this variable is tied to three survey questions: R4 (Room temperature) (Figure 5.16). The difference between the two variables is substantial between 33.6% change. The relationship demonstrates that there is a possible relationship of rooms with beds located within the room influence the perception of room temperature.

5.5. Discussion

This study was intended to begin to identify factors that may influence patient self-reported outcomes through the statistical exploration of association of variables. Within the six survey questions that were identified as having a significant relationship to patient self-reported outcome questions, there was only one question, N1, that had a relationship to the age of the patient (Table 5.16). This suggests it is reasonable to disregard the impact patient characteristics had on patient self-reported outcome overall in this study. Through a chi-squared analysis, age is correlated to room.

Table 5-16 Overview of statistically significant results only of both spatial and patient variables identified through Logistical regression analysis $p < 0.05$, n=3,751

	Patient Characteristic			Room Characteristic				
	Admit	Age	Gender	Average Distance to RN Station	Handed	location of Bed	window	first encounter
	P Value	P Value	P Value	P Value	P Value	P Value	P Value	P value
Dependent Satisfaction Variable								
N 1 Nurses: Friendliness/ courtesy of the nurse		0.045						0.00
P 1 Physician: physician's concern for your question and worries					0.018			
P 5 Physician: Skill of Physician					0.003			
I 1 Staff concern for your privacy								0.00
I 3 Personal Issue: How well was your pain controlled					0.028			
I 4 Response to concerns/ complaints made during your stay							0.00	

The impact of the organizational culture needs to be noted in this study. In review of the unit performance by % of top box rooms, the G unit has 10% of the rooms scoring at top box whereas the B unit has less than five%. The unit performance, and the little variation of the window and location of bed, could have been an influencer in one of the findings. It should also be noted that the location of first encounter is not varied by unit and all of the G rooms have hand wash sinks facing the patient.

Research findings completed to date confirm there is a need for further study to define how spatial layout could be applied in the design process to help improve overall patient self-reported outcomes. The results of this work show that there may be a plausible relationship between spatial layout and patient self-reported outcomes and experience. There needs to be further work completed at other units, using other variables that are clearly more evenly distrusted by the environment.

This next study explores a greater sample population than the original population, within the same hospital campus. This further research study confirms that there is a statistically significant relationship of spatial variables and certain satisfaction questions.

6. General study

6.1. Methods

Patient self-reported outcomes is an outcome variable most closely related to the service quality of an organization. The environmental impact on allowing care to be delivered has not been analyzed beyond just the aesthetical value. This study is exploring the plausible relationship between patient self-reported outcome and room layouts, while maintaining awareness of the moderating variables of culture and patient characteristics. A survey analysis tool administered by Press Ganey was used. The survey tool contained questions concerning patient care in the room were coded to the room of discharge at a tertiary academic medical facility in the southern United States. There are 4,615 individual surveys from patients discharged from 81 room types at Emory University Hospital from July 2012 to June 2014 (Table 6.1). Two years of surveys on 15 units were coded to binary "top box" normally distributed data and analyzed through logistical regression to categorize patient and spatial characteristics of the room and unit. . The study uses a series of questions as an isolation method of looking at possible influencing moderators. The various variables include the Press Ganey and HCAHPS scores, patient characteristics, and spatial variables, all of which have been identified as significant variables through previous research. The study was approved by the Georgia Institute of Technology's review board (IRB).

Table 6-1 General field study population sample size and distribution on the three units

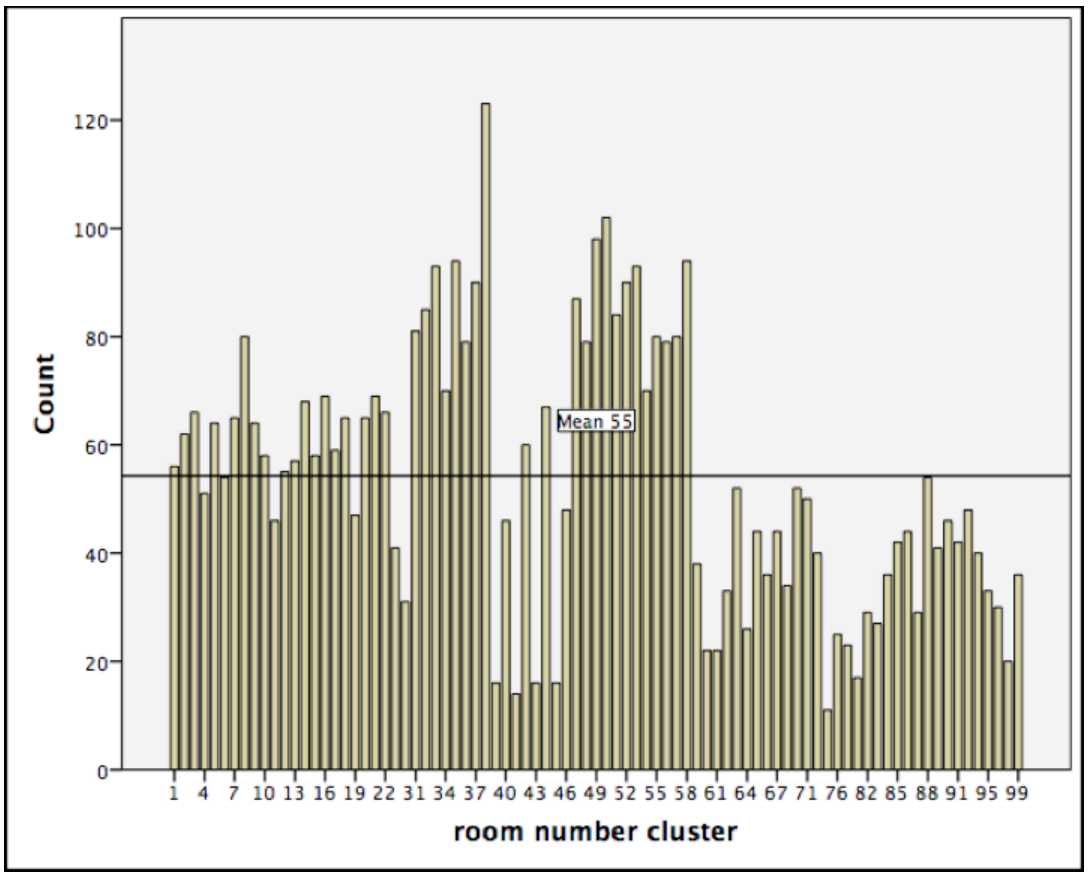
General Population						
IT UNIT	Unit specialty	NUMBER OF ROOMS	Total Room Types	SURVEYS PER UNIT	Total Surveys per Unit Type	AVG NUMB SURVEY PER ROOM
B4	EUH Cardiovascular	32	33	600	1,099	19
B5-N	EUH Vascular Thoracic	16		225		14
B5-S	EUH Pulmon Thoracic	16		274		17
E6	EUH Hematology	23	24	106	1,416	5
E7	EUH Oncology	23		171		7
E8	EUH Oncology	23		131		6
E9	EUH General Surgery	23		305		13
E10	EUH General Surgery	23		254		11
E11	EUH Gyn Gen Surgery	23		449		20
G2	EUH Neuro-Sciences	24	24	244	2,100	10
G3	EUH Neuro-Sciences	24		425		18
G4	EUH Cardiology/ Coronary	24		616		26
G5	EUH General Medicine	14		138		10
G6	EUH General Medicine	24		228		10
G7	EUH Med Surg	29		449		15
15	**TOTALS**	**341**	**81**	**3 Types**	**4,615**	**14**

The intent for this study is to have a more general population with greater variability in nursing practices and protocols. All patient types and diagnosis were included in this study, whereas Phase I (Preliminary Study) was limited to cardiac patients only. It is important to note that there may be greater influencers of culture and practices that could skew the outcomes or lead to false positive relationships. An important goal of this study was to explore potential moderating variables. This research study includes three unit types from 15 floors at EUH. The 45% of the surveys from the G units represent the most surveys collected on a single unit. The least amount of surveys were from the B unit at 24% (Table 6.2). The rooms on the unit were grouped by similar room types, where 55 surveys represent the overall mean (Figure 6.1).

Table 6-2 Frequency distribution of patient surveys by unit

	Frequency	Percent
G Unit	2,100	45.5
B Unit	1,099	23.8
E Unit	1,416	30.6
	4,615	100

Figure 6-1 The distribution of surveys by room of discharge. The mean number of surveys for the study is 55 surveys per room cluster. Rooms are cluster by room type and number



6.1.1. Study setting

The study setting is a 579-bed tertiary care, academic medical center in the Southern United States. As the focus of this study is spatial layout and architectural design, the study setting has three various settings and unit configurations that influence multiple spatial variables

within the operation of that department (Figure 6.2). Setting B includes two floors and three different specialty units. It is a single-loaded corridor layout containing 32 rooms total with 16 on each wing (corridor unit). The second setting, G, is laid out in a double corridor configuration and contains 24 rooms per unit of six floors (Racetrack Unit). The specialties included in the G unit are neuro-sciences, cardiology, and general surgery. The final unit is the E unit, which is a triangular unit configuration and has 23 rooms per floor with six floors included in the study (Triangular Unit). The patient population on this unit is hematology, oncology, and general surgery. The unit layouts were categorized using James and Tatton-Brown's patient unit typology (1986). All units have a central nurse's station and movable workstations on wheels for electronic management of the patient.

Figure 6-2 Study setting by units at Emory University Hospital for both field studies. There are three unit types: Corridor (B), Racetrack (G), and Triangular (E).

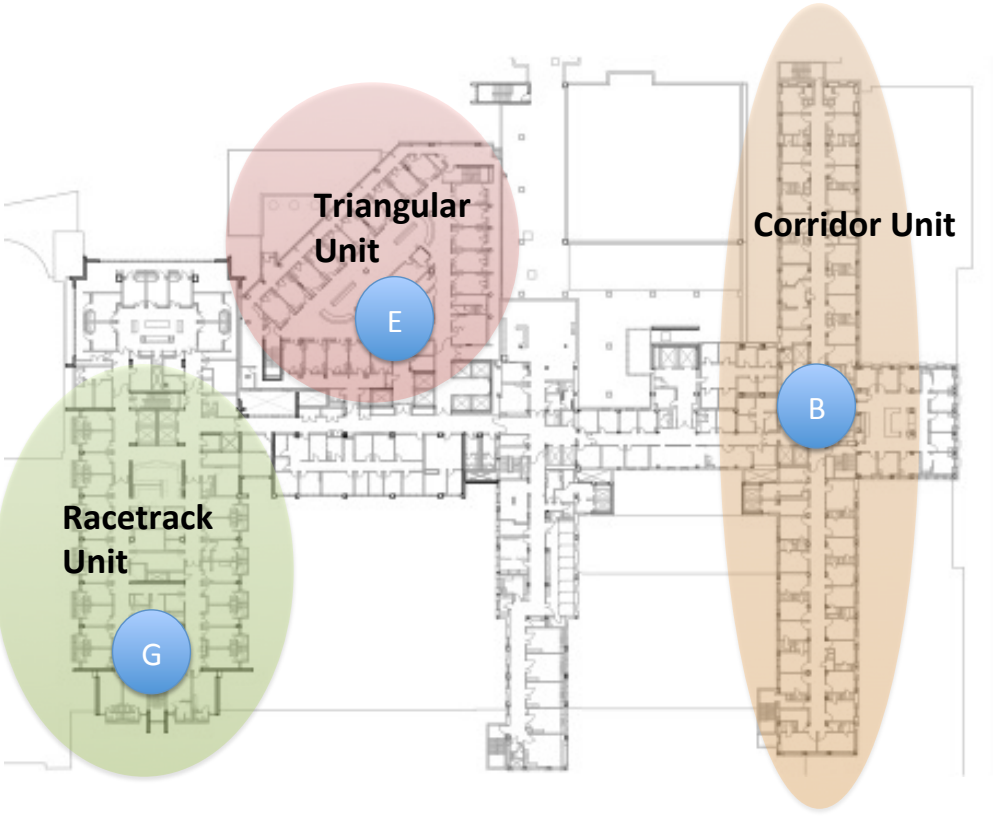
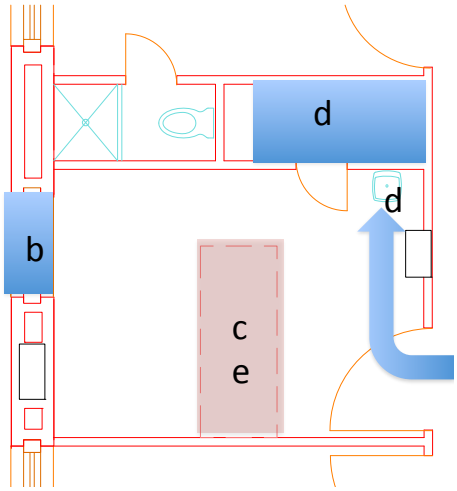
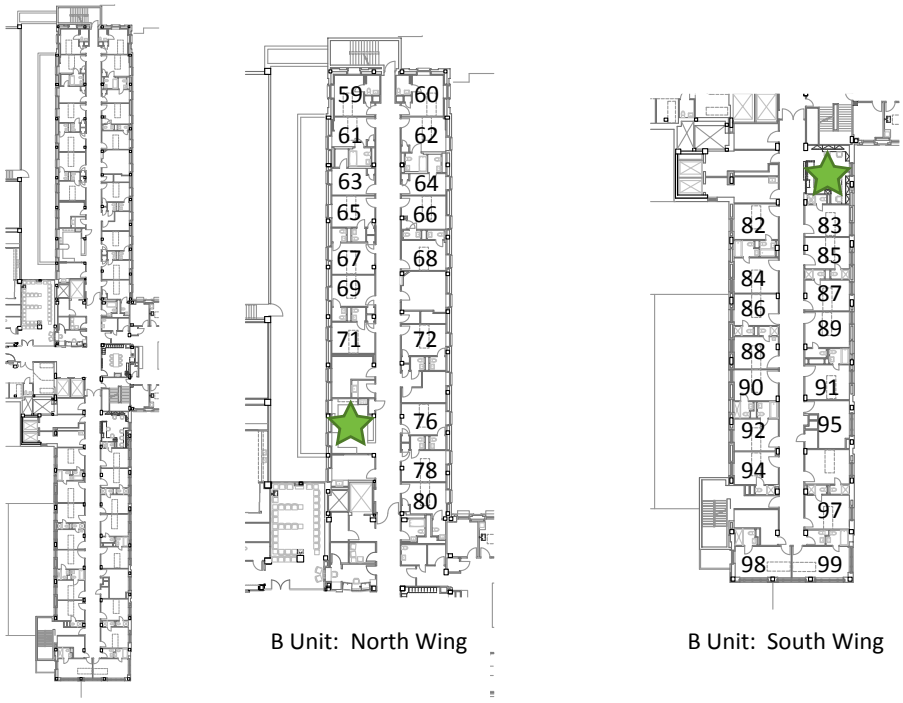


Figure 6-3 Corridor unit (B) study setting at Emory University hospital typical room layout and identified spatial variables.



a. Room size: 152.6 SF mean size
b. Window opening: 3 feet 6 inches wide
c. Room Handedness: Right or Left
d. Location of first encounter: 2, 3
e. Location of door to head of patient: 2

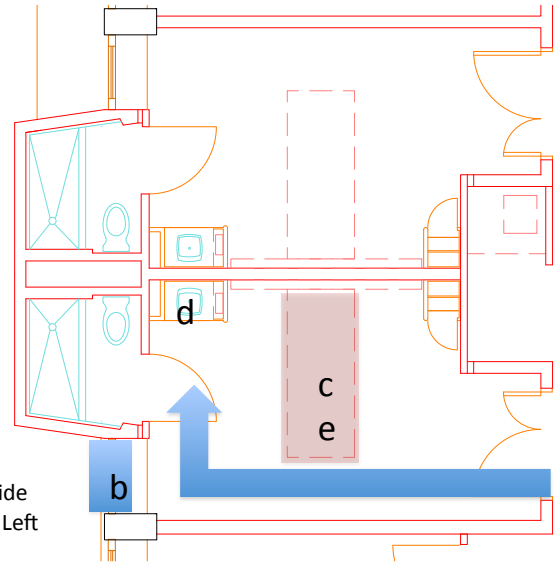
Figure 6-4 Corridor unit (B) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.



B Unit: North Wing

B Unit: South Wing

Figure 6-5 Racetrack unit (G) study setting at Emory University hospital typical room layout and identified spatial variables.



a. Room size: 173 SF mean size
b. Window opening: 2 feet 4 inches wide
c. Patient Room handedness: Right or Left
d. Location of first encounter: 1
e. Location of door to head of bed: 1

Figure 6-6 Racetrack unit (G) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.

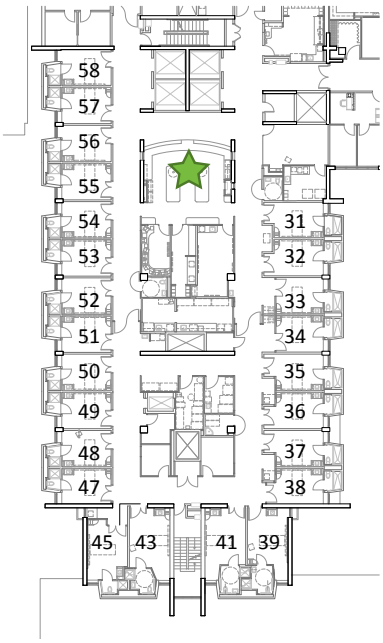


Figure 6-7 Triangular unit (E) study setting at Emory University hospital typical room layout and identified spatial variables.

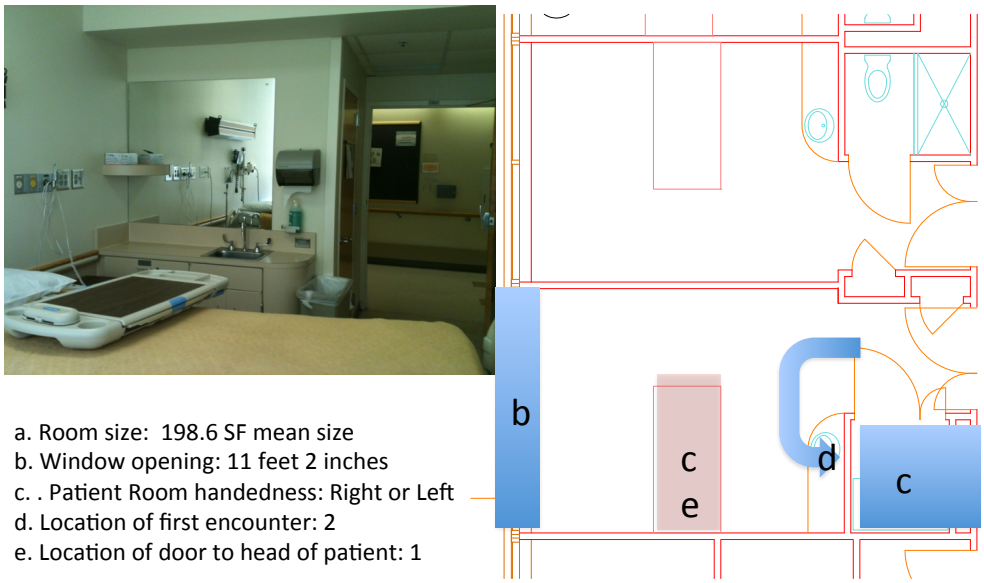


Figure 6-8 Triangular unit (E) study setting at Emory University hospital typical unit layout and study room numbers. Each floor is identical and rooms are stacked. Central nurses station is identified with the green star.

All patient rooms, in both units, were private and contained a hand wash sink. All units had one single, central nurse's station (Figure 6.4, 6.6,6.8). Unit G had more hand wash sinks at the head of the patients' bed than Units B or E (Figure 6.3, 6.5, 6.7). The room sizes were similar, with the largest rooms in the E unit at 199 square feet. Most of the patient rooms had toilets and showers: one-half of the rooms in Unit B-S had no showers. Window sizes were aligned with the unit type, with the largest windows in the E unit and the smallest in the G unit. All other physical components of the rooms in both units were similar, including furniture and finishes.

The moderating patient characteristics are noted in the study population and the specific characteristics were chosen based on previous research of identified possible influencers of satisfaction outcomes. These influencing characteristics are: age (Rosenheck et al., 1997; Williams & Calnan, 1991), gender (Hall Judith A., 1990; Williams & Calnan, 1991), admission through Emergency Department, and self-rating of health.

40 survey questions from Press Ganey and Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) were used in this study. Questions were selected based on their direct relationship to patient care in the patient room by staff and physicians. Room and environment questions were also included because of their direct connection to room-based variables. Completed surveys were coded and entered into a database by the author. All patient identifiers had been removed from the data prior to the author receiving the information. Survey data was recoded to create a binary data set that was more normally distributed and representational of leading indicators of patient self-reported outcomes (Jha et al., 2008). This re-coding created a category for the highest score possible in the Press Ganey and HCAHPS survey questions and a second category for the other scores. This analysis is representational of the "top box" rating.

6.1.2. Data analysis

Data analysis was conducted using IBM SPSS Statistics 22 for Macintosh. Descriptive statistics were reported for an understanding of the population characteristics and the responses by room type. Descriptive statistics were also reported for categorical variables using frequencies and proportions. Chi-squared tests were used to see if patients were assigned to rooms randomly or if there was a tendency for certain patients to be assigned to similar rooms. Finally, logistical regression was used to determine if the survey top box outcome was influenced by spatial variables. The dependent binary satisfaction survey outcome and the independent multiple categorical spatial characteristic variable were modeled and statistical significance was assessed using $p < 0.05$.

6.2. Findings

6.2.1. What are the sample population's characteristics?

Descriptive statistics revealed 51.2% (2,361) of the respondents were male and 48.8% (2,544) female. A comparison of the number of surveys returned by gender and unit showed a similar gender ratio, suggesting no gender bias existed in room assignments (Table 6.2). 50% of patients in the sample were between 35 and 49 years of age and there was similar representation in both units. Just over 40% of the patients (41.1%) were not admitted through the emergency department. Patient's significantly rated their own health poor (93%) as well as indicating they had poor mental health (78%). There were no outliers or inconsistencies within the patient population by unit or in the patient characteristics representative on both units.

Table 6-3 Frequency distribution of patient surveys by patient characteristics categories and sorted into units

		Total N(%)	Unit B- N	Unit E- N	Unit G- N
Age	18-34	818 (17.7)	223	166	429
	35-49	2309 (50)	569	744	996
	50-64	1433 (31)	285	506	642
	65+	54 (1.2)	21	0	34
Gender	Male	2361 (51.2)	609	689	1063
	Female	2254 (48.8)	489	727	1038
Admittance	Emergancy	1452 (31.5)	328	369	755
	Non Emergency	1898 (41.1)	442	715	741
	Not specified	1265 (27.4)	328	332	605
Rate of Mental Health	Poor	3600 (78)	861	1055	1684
	Good	1015 (22)	237	361	417
Rate of Overall Health	Poor	4293 (93)	1040	1266	1967
	Good	322 (7)	58	130	134

6.2.2. Is there a relationship between room of discharge and satisfaction scores?

The initial test sought to determine if there is a plausible relationship between room of discharge and satisfaction survey. Through the analysis, there was a clear relationship of individual survey scores tied to the room types. 29 of the 43 survey questions were significantly related to the room of discharge. What was connecting the survey to the room? What created the relationship? With the variation of patient types in the room, and the amount of surveys collected per room, this strong relationship cannot be by chance - there has to be something that is creating that relationship. Could it be that the actual room functions at the same level for each patient?

6.2.3. Do certain categories or locations of rooms explain better room performance? (number of top box scores on average in the room of discharge during the study period)? Is there a visual pattern of room performance?

Further exploration of the room performance and unit performance were explored through the developed average of all the survey question scores for that room and patient evaluation using the established top box score. Each of the established variables was continuous. A descriptive analysis was explored to see the frequency of top box scores by room and unit. The score was then ordered by the highest to lowest frequency for top box scores by room and unit.

The E unit is higher performing (2.5% of top box) than the G unit (2.1% top box) and the B unit (.8% top box). These unit performances match the findings from the preliminary data set (FIGURE 6.9, 6.10.6.11). Highest performing rooms listed by room number, are (0.2%): 3,5,8,9,14,17,18 and 50.

Lowest performing rooms listed by room number, are (0%): 24,41,59,60,62,64,68,72,74,80,83 and 88.

At first glance of the visual map, there did not seem to be any obvious patterns or physical indication as to why the room scores were so varied. It was also interesting that in the B unit, the rooms without any showers had the highest scores. Although this physical component was not a part of this initial study, it may be worth pursuing in future studies as related to amenities.

Figure 6-9 Visually map identifying room performance mapped on the floor plan of the B unit. Red indicate negative mean scores for the study and green indicate highest mean score by unit

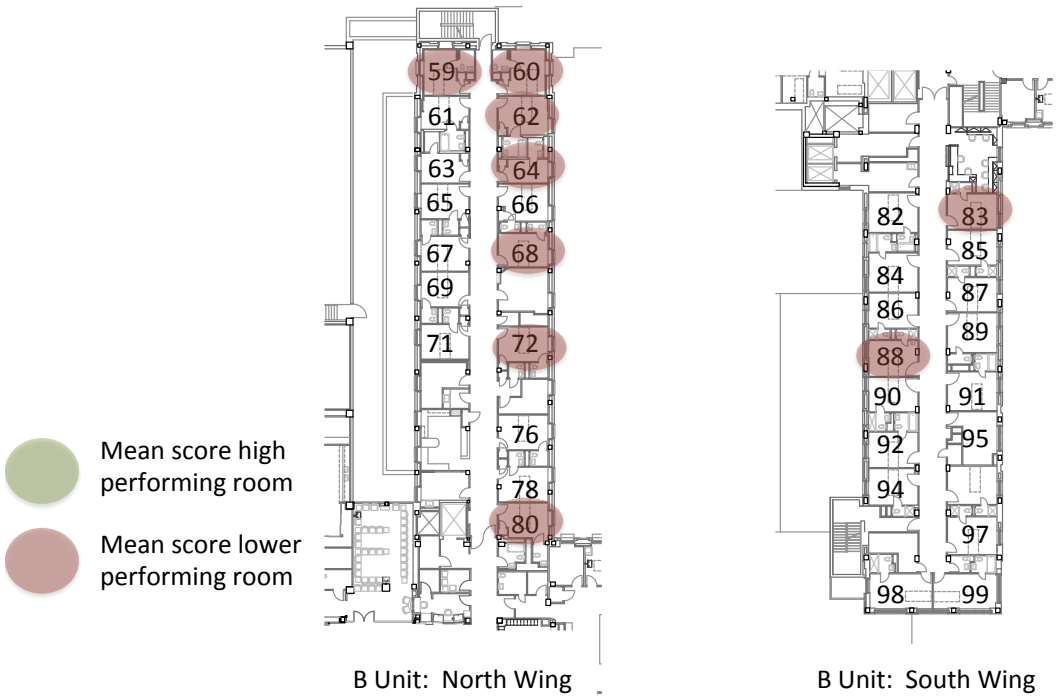
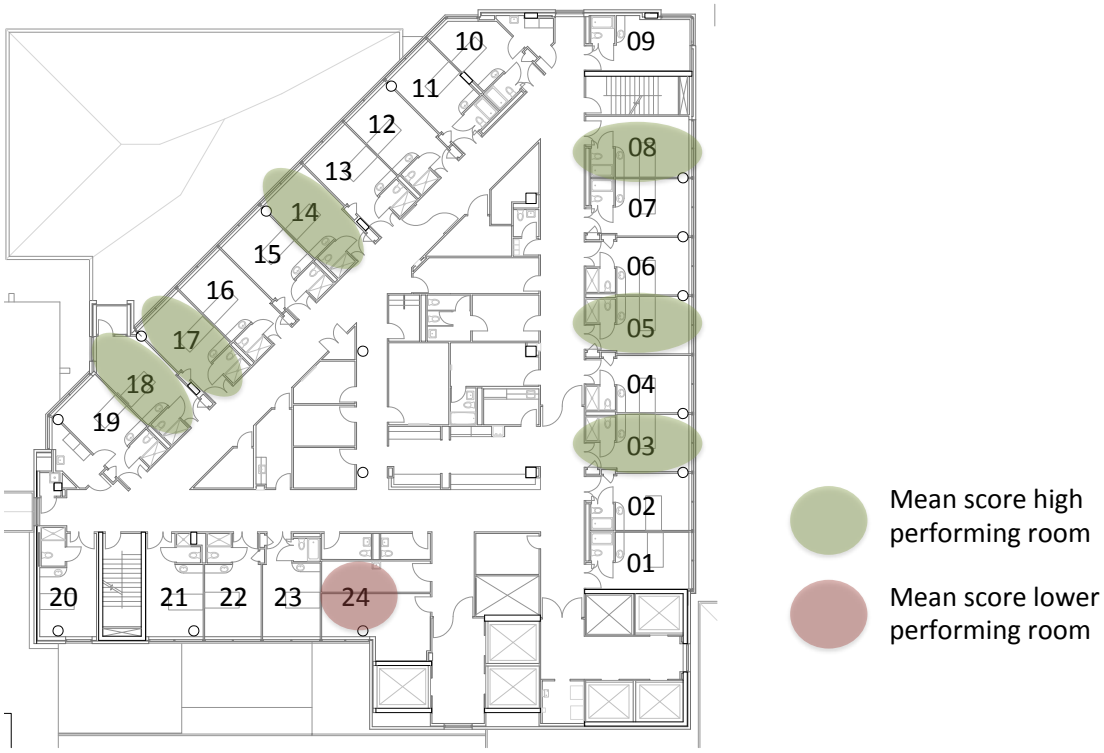


Figure 6-10 Visually map identifying room performance mapped on the floor plan of the G unit. Red indicate negative mean scores for the study and green indicate highest mean score by unit

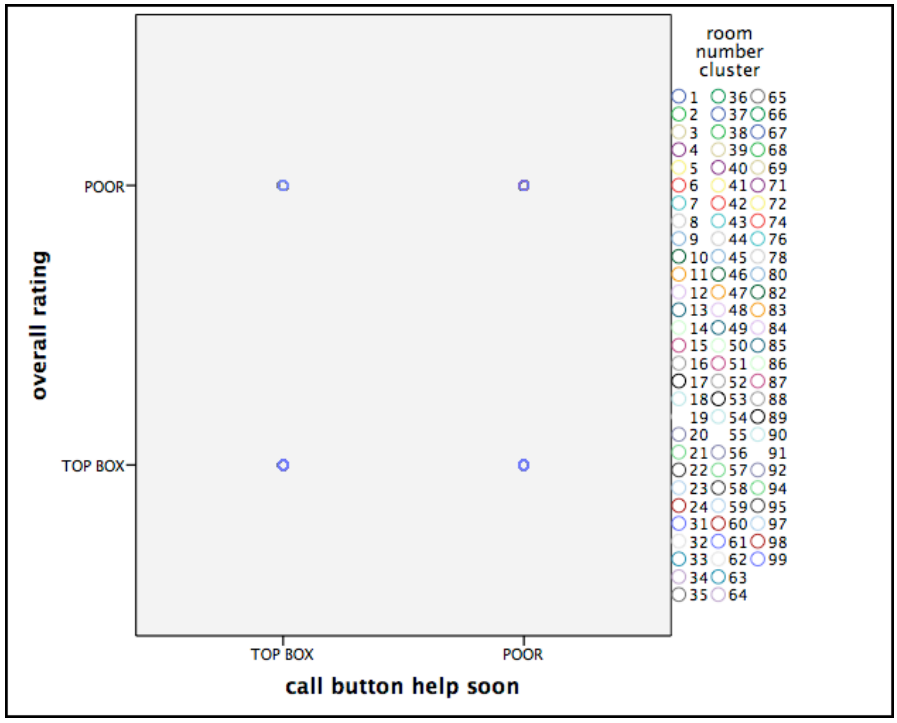
Figure 6-11 Visually map identifying room performance mapped on the floor plan of the E unit. Red indicate negative mean scores for the study and green indicate highest mean score by unit



6.2.4. Are the individual satisfaction questions related? Does each question follow the same result?

The next level of analysis was to see if there was any correlation between patient self-reported outcome scores and rooms. Were there rooms that had greater variation between the two patient self-reported outcome scores investigated? This was done through a scatter plot Figure 6.12. The coefficient of determination is .124 for this relationship. These studies show that there is no relationship between the two scores analyzed. Therefore, each question should be considered an independent variable not tied to any other survey questions. This study question was explored but deemed not relevant based on the binary data set of outcomes.

Figure 6-12 Sample score difference between overall satisfaction and promptness satisfaction



6.2.5. Are the patients assigned to rooms randomly? Is there a correlation between room type/number and patient characteristics?

Could room performance be tied to the type of patients that are assigned to the room? Using Pearson's chi-squared test to compare patient characteristics to room type, it showed that age, admission type, and rate of health could be an influencing factor on the room performance (Table 6.4). If all older patients, or one-gender patients, were assigned to a certain room, this could create a bias. This test is looking at the general patient characteristics and not the categorical variables. This is to further define if there is a relationship. If all older/ younger patients or one-gender patients were assigned to a certain room, this could create a bias.

Table 6-4 Chi squared analysis exploring the relationship of room and patient characteristics for the general field study.

Effect	df	Pearson Chi-Squared Sig
ED Admit	168	.000
Gender	84	.213
Age	336	.000
Rate overall health	84	,003
Rate Mental Health	84	.007

6.2.6. Do patient characteristics completely explain satisfaction scores?

Are the survey outcomes directly related to the type of patient? This part of the analysis is where we look to the work that has been done previously and suggests that the type of patient can predict the outcome of the survey score (Sitzia & Wood, 1997). The dependent variable is the individual patient self-reported outcome scores for all questions. The independent variable is the individual patient type: gender, age, rate of mental health, rate of overall health, and admission type. All of the explored variable characteristics in this sample showed a relationship to the room of discharge.

To further review the correlation of the room, the patient characteristics that have been identified as key possible influencers of satisfaction are gender, age, and admission type. Through logistical regression analysis, the only significant variables that may tie to the room would be gender or age. Logistical regression analysis ($p < .05$) was used to show a relationship between room of discharge and patient characteristics to most every question with one characteristic. Therefore, we cannot disregard the possible impact admission type has in this study. This is possibly because the number of responses per room averaged 55 and that provides a high enough sample to level the effect of this known variable. It should also be noted that the coding of admission type by patient survey was not always completed, so there are many surveys that have no data tracked to this variable, which could also impact the results.

6.2.7. Do room categories and unit types have significantly different patient profiles or patient characteristics?

This section summarizes the distribution of the room spatial characteristics by unit. Within this study, the sample spatial variables included five categorical variables over two units as shown in Table 6.5. The five components of the spatial layout investigated in this exploratory research, and their relationship to patient self-reported outcome, need further study. The sample spatial variables included five categorical variables over three unit and 81 room types: room handedness, window opening, distance to the nurse station, location of first encounter, and location of bed. The room handedness was equally representative on all units with 49.5% more rooms being left-handed than right. The majority of the beds were located within the room at 85.6%. Both the B and the G unit have beds at the door, but it represents 14.4% of the sample. 46.5% of the location of first encounter variable occurs facing the patient, and that is from units B and G. Back-facing rooms are 37.9 % of all units. Medium distance (36-70 lineal feet) to the nurse's station is the most frequent at 41.5%. Window opening has little variation between units. The lack of variation of the window size by unit was noted and is a concern for the author that it could have a further moderating effect.

Table 6-5 Frequency distribution of returned survey's by spatial variables and unit of discharge, n=4,615

		Total N(%)	Unit B N(%)	Unit E N(%)	Unit G N(%)
Window opening length	small (less than 5 feet)	2303 (44.1)	0 (0)	0 (0)	2303 (44.1)
	medium (5 to 10 feet)	1296 (28.1)	1099 (23.8)	130 (2.8)	67 (1.5)
	large (11+ feet)	1286 (27.9)	0 (0)	1286 (27.8)	0 (0)
Distance to the nurses station	short (1-35 lineal feet)	1317 (28.6)	209 (4.5)	437 (9.5)	671 (14.5)
	medium (36-70 lineal feet)	1925 (41.5)	420 (9.1)	792 (17.2)	713 (15.4)
	long (71+ lineal feet)	1373 (29.7)	469 (10.2)	187 (4.1)	717 (15.5)
Point of first encounter	facing	2147 (46.5)	85 (1.9)	0 (0)	2062 (44.7)
	back	1751 (37.9)	296 (6.4)	1416 (30.7)	39 (.8)
	in the toiet room	717 (15.5)	717 (15.5)	0 (0)	0 (0)
Location of bed	within room	3951 (85.6)	458 (9.9)	1416 (30.7)	2077 (45)
	at door	664 (14.4)	640 (13.9)	0 (0)	24 (.5)
Oreintation of Bed/ Room handed	Right	2331 (50.5)	522 (11.3)	740 (16)	1069 (23.2)
	Left	2284 (49.5)	576 (12.5)	676 (14.6)	1032 (22.4)

6.2.8. Are Differences in satisfaction scores explained by spatial characteristics of the room and unit?

Through logistical regression, each of the 41 survey questions was individually analyzed with the five spatial variables. 11 of the survey questions were found to show a statistically significant relationship with a p value of less than 0.05 (Table 6.6).

Table 6-6 Survey questions that had a statistically significant relationship to spatial variables through logistical regression

Dependent Satisfaction Variable
N 3: Nurses Attitude
N 5: Nurses kept you informed
CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?
CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?
P 4 Physician: Friendliness/courtesy of physician
P 5: Skill of the physician
I 4 Response to concerns/ complaints made during your stay
R 1 Room: Pleasantness of room décor
R 2 Room: Room Cleanliness
R 4 Room: Room temperature

The spatial variables were tied to four focus categories of the satisfaction survey; they include room (3), physician (2), and nursing (4).

Table 6-7 Spatial variables and R1 satisfaction question. Relationship identified through Logistical regression analysis p <0.05, n=4,615

	R 1 Room: Pleasantness of room décor						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
first encounter	0.178	0.043	17.355	1	0.000	1.195	0.005
room handed	0.17	0.061	7.75	1	0.005	1.185	0.002
average distance to nurse station	0.080	0.04	4.036	1	0.045	1.084	0.001

Three of the spatial variables shown in Table 6.7 (first encounter, room handed, and distance to nurse's station) were found to be significantly related to pleasantness of the room décor (b= .08 to .178, p,<0.05). Locating the patient room at the medium distance from the nurse station (36-70 lineal feet) increases the odds of achieving top box scores on the patient self-reported outcome survey question of a pleasant room décor by 8.4%. Placing the location of first encounter to face the patient increased the odds of achieving top box scores of the patient self-reported outcome survey of a pleasant room décor by 19.5%. Finally, the right-handed rooms have an increased odd of achieving top box scores on the patient self-reported outcome survey question concerning pleasant room décor by 18.5%.

Table 6-8 Spatial variables and R 2 satisfaction question relationship identified through Logistical regression analysis p <0.05, n=4,615

	R 2 Room: Room Cleanliness						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
first encounter	0.105	0.041	6.639	1	0.010	1.111	0.002
room handed	0.177	0.059	9.05	1	0.003	1.194	0.003
location of bed	-0.308	0.084	13.357	1	0.000	0.735	0.004

Three of the spatial variables (first encounter, room handedness, and location of the bed) were found to be significantly related to survey item R2: Room cleanliness (Table 6.8). More specifically, there are three spatial variables that have been shown to associate with the score of room cleanliness (R 2). The location of first encounter significantly predicts R2 (b=0.105, p<0.05). Locating the hand wash sink so staff can face the patient increase the odds of achieving top box scores of R2 question by 11%. The location of the bed also significantly predicts R2 (b=-0.308, p<0.05). Locating the bed at the door decreases the odds of R2 being top box by 26.5%. The handedness of the room significantly predicts R2 (b=0.177, p<0.05). Right-handed rooms can increase the odds of R2 to achieve top box by 19.4%.

Table 6-9 Spatial variables and R4 satisfaction question relationship identified through Logistical regression analysis p <0.05, n=4,615

	R 4 Room: Room temperature						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
first encounter	0.204	0.042	23.793	1	0.000	1.226	0.007
room handed	0.14	0.06	5.47	1	0.019	1.15	0.002
location of bed	-0.604	0.091	43.945	1	0.000	0.547	0.013
average distance to nurse station	0.093	0.039	5.642	1	0.018	1.098	0.002

Four of the spatial variables (first encounter, room handed, location of bed, and distance to nurse station) were shown to be significantly related to survey question R4: Room temperature (Table 6.9). More specifically, location of first encounter, room handedness, location of the bed, and average distance to the nurse's station all predict room temperature. Location of first encounter predicts R4 (b=0.204, p<0.05). A location of first encounter that faces a patient can increase the odds of achieving top box scores on R4 by 22.6%. The right-handed room predicts R4 (b=0.14, p>0.05) and can increase the odd of the top box by 15%. The location of the bed significantly predicts R4 (b=-0.604, p<0.05). Locating a bed at the door decreases the odds of

achieving top box scores of R4 by 45.3%. Locating the patient room at the medium distance from the nurse's station (36-70 lineal feet) is significantly related (b=0.093, p<0.05) to R4 and increases the odds of achieving top box scores of the patient self-reported outcome survey question of room temperature by 9.8%.

Table 6-10 Spatial variables and CMS 1 satisfaction question relationship identified through Logistical regression analysis p <0.05, n=4,615

	CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
window opening	-0.101	0.038	6.949	1	0.008	0.904	0.002

One spatial variable (window opening) was shown to be significantly related to survey item CMS 1: Your care from nurses: During this hospital stay, how often did nurses treat you with courtesy and respect? (Table 6.10). The size of the window length significantly predicts the CMS 1 patient self-reported outcome question (b=-0.101, p<0.05) and a smaller window length can increase the odds of achieving top box by 9.6%.

Table 6-11 Spatial variables and satisfaction question CMS 2 relationship identified through Logistical regression analysis p <0.05, n=4,615

	CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
window opening	-0.095	0.036	6.874	1	0.009	0.909	0.002

One spatial variable (window opening) was shown to be significantly related to survey item CMS 2: Your care from nurses: During this hospital stay, how often did nurses listen carefully to you? (Table 6.11). More specifically, the size of the window length significantly predicts the CMS 2 patient self-reported outcome question (b=-0.095, p<0.05) and a smaller window length can increase the odds of achieving top box by 9.1%.

Table 6-12 Spatial variables and N3 satisfaction question relationship identified through Logistical regression analysis *p* <0.05, n=4,615

	N 3: Nurses Attitude						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
average distance to nurse station	0.088	0.042	4.435	1	0.035	1.092	0.001

One spatial variable (distance to nurse station) was shown to be significantly related to survey item N3: Nurses attitude (Table 6.12). More specifically, the average distance to the nurse's station significantly predicts the patient perception of nurse's attitude (b=0.088, p<0.05). Locating a patient room at the medium distance from the nurse's station (36-70 lineal feet) increases the odds of achieving top box scores on the patient self-reported outcome survey question of nurse's attitude by 9.2%.

Table 6-13 Spatial variables and N5 satisfaction question relationship identified through Logistical regression analysis *p* <0.05, n=4,615

	N 5: Nurses kept you informed						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
average distance to nurse station	0.085	0.04	4.365	1	0.037	1.088	0.001

One spatial variable (distance to nurse station) was shown to be significantly related to survey item N5: Nurses kept you informed (Table 6.13). More specifically, the average distance to the nurse's station significantly predicts the patient perception of nurse's kept you informed (b=0.085, p<0.05). Locating the patient room at the medium distance from the nurse station (36-70 lineal feet) increases the odds of achieving top box scores of the patient self-reported outcome survey question of nurse's kept you informed by 8.8%.

Table 6-14 Spatial variables and satisfaction question P4 relationship identified through Logistical regression analysis *p* <0.05, n=4,615

	P 4 Physician: Friendliness/courtesy of physician						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
average distance to nurse station	-0.093	0.044	4.498	1	0.034	0.912	0.001

One spatial variable (distance to nurse station) was shown to be significantly related to survey item P4: Physician: friendliness / courtesy of physician (Table 6.14). More specifically, the average distance to the nurse's station significantly predicts the patient perception of friendliness/courtesy of physician (b=-0.093, p<0.05). Locating the patient room at the midpoint of the corridor can increase the odds of achieving top box scores on the question friendliness/courtesy of physician by 8.8%.

Table 6-15 Spatial variables and P5 satisfaction question relationship identified through Logistical regression analysis *p* <0.05, n=4,615

	P 5: Skill of the physician						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
location of first encounter	-0.164	0.05	10.889	1	0.001	0.849	0.004

One spatial variable (first encounter) was shown to be significantly related to survey item P5: Skill of the physician (Table 6.15). More specifically, location of the first encounter significantly predicts the patient's perception of skill of the physician (b=-0.164, p<0.05). Having the hand wash sink oriented toward the patient increases the odds of achieving top box scores of the patient self-reported outcome survey question P5 skill of the physician by 15.1%.

Table 6-16 Spatial variables and I4 satisfaction question relationship identified through Logistical regression analysis *p* <0.05, n=4,615

	I 4 Personal Issue: Response to concerns/ complaints						
	b	se	Wald chi squared	df	p value	Exp(B)	nagelkerke R squared
Window Length	-0.095	0.036	7.081	1	0.008	0.909	0.002

One spatial variable (window opening) was shown to be significantly related to survey item I 4 Personal Issues: Response to concerns/ complaints (Table 6.16). More specifically, window opening significantly predicts the patient's perception of response to concerns and complaints (b=-0.095, p<0.05). Rooms that have small window opening below three feet increases the odds of achieving top box scores of the patient self-reported outcome survey question P5 skill of the physician by 9%.

To summarize, all five spatial variables (average distance to nurses station, window opening, room handedness, location of bed and location of first encounter) were found to directly relate to seven survey questions.

6.2.9. What is categorical spatial variable performance? Explore the possible room type performance based on the findings from the analysis (number of top box scores in that room during the study period)?

Table 6-17 Percent of top box distribution for spatial variables(average distance to nurses station, window opening) and satisfaction question relationship identified through Logistical regression analysis *p* <.05, n=4,615

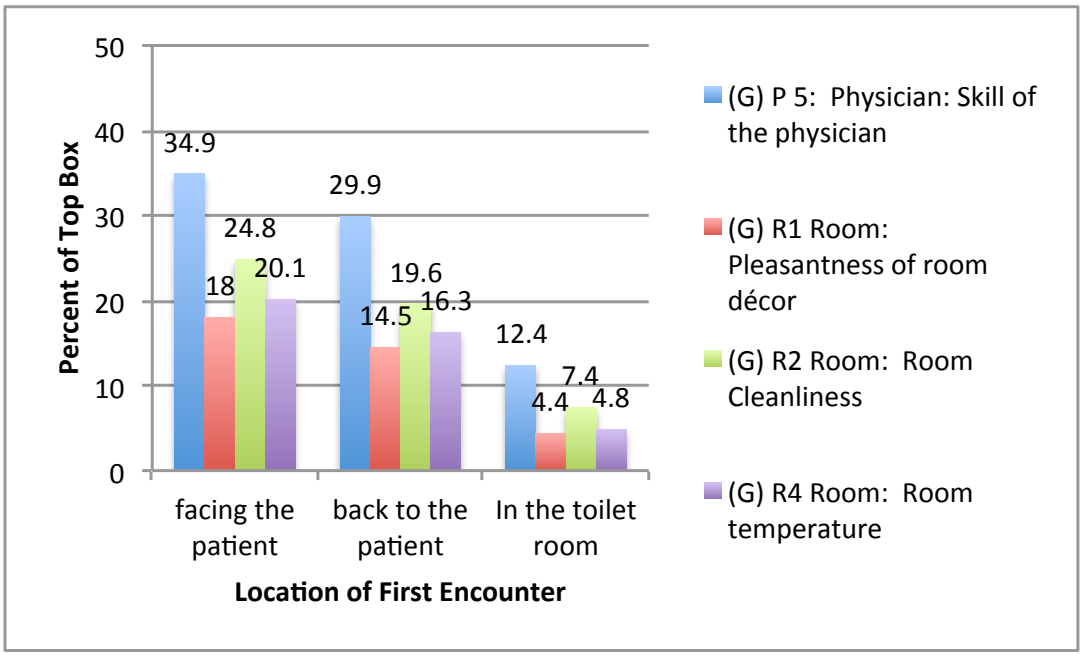
	average distance to nurses station			window opening		
	short	medium	long	Small	medium	Large
Dependent Satisfaction Variable	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)
N 3: Nurses Attitude	934 (20.2)	1356 (29.4)	922 (20)			
N 5: Nurses kept you informed	871 (18.9)	1272 (27.6)	855 (18.5)			
CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?				1375 (29.8)	841 (18.2)	934 (20.2)
CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?				1194 (25.9)	743 (16.1)	820 (17.8)
P 4 Physician: Friendliness/courtesy of physician	921 (20)	1456 (31.5)	1010 (21.9)			
I 4 Response to concerns/ complaints made during your stay				1098 (23.8)	711 (15.4)	757 (16.4)
R 4 Room: Room temperature	567 (12.3)	806 (17.5)	529 (11.5)			

Table 6-18 Percent of top box distribution for spatial variables(room handed, location of bed, location of first encounter) and satisfaction question relationship identified through Logistical regression analysis *p* <.05, n=4,615

	room handed		location of bed		location of first encounter		
	right	left	in room	at door	facing	back	in room
Dependent Satisfaction Variable	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)	Top Box N(%)
P 5: Skill of the physician					1612 (34.9)	1382 (29.9)	574 (12.4)
R 1 Room: Pleasantness of room décor	906 (19.6)	797 (17.3)			831 (18)	668 (14.5)	204 (4.4)
R 2 Room: Room Cleanliness	1258 (27.3)	1131 (24.5)	2089 (45.3)	300 (6.5)	1144 (24.8)	905 (19.6)	340 (7.4)
R 4 Room: Room temperature	1000 (21.7)	902 (19.5)	1707 (37)	195 (4.2)	929 (20.1)	752 (16.3)	221 (4.8)

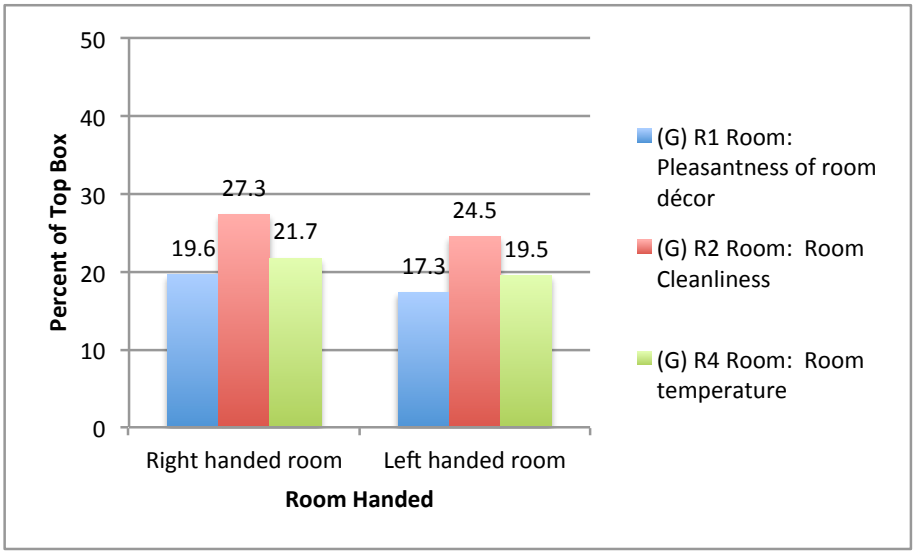
Exploring the survey questions that showed a direct relationship to spatial variables, this section of the study looks more closely at the performance variation by characteristic and question as a whole to see what the possible impact is in this identified relationship (Table 6.17-6.18).

Figure 6-13 Percent of top box distribution for location of first encounter and satisfaction question relationship identified through Logistical regression analysis $p < .05$, n=4,615



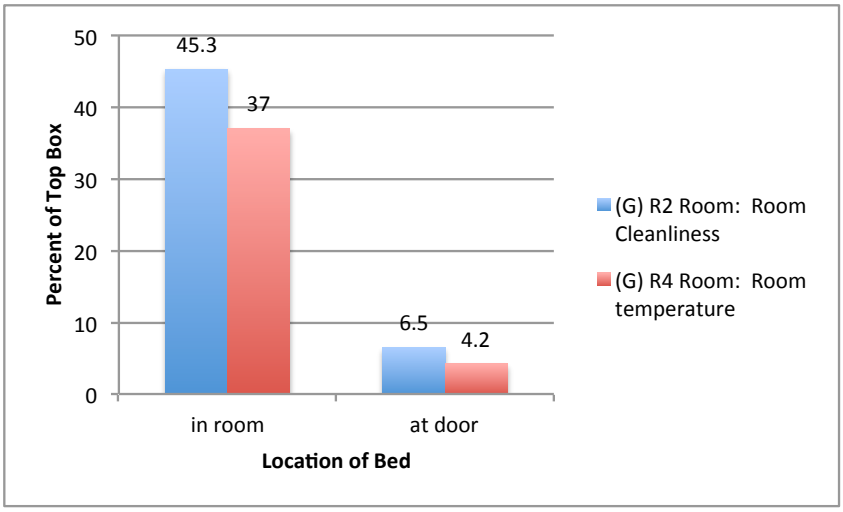
Three survey questions were shown to be plausibly related to location of first encounter (Figure 6.13). They include: P5 (Physician: Skill of the physician), R1 (Room: Pleasantness of room décor), and R2 (Room: Room Cleanliness). Rooms with hand wash sinks facing the patient were found to have the highest percentage of top box scores on these three survey questions. The rooms with hand wash sinks in the toilet room scored the lowest. The standard deviation on top box scores for rooms facing the patient ranged from 3.5-5.2%.

Figure 6-14 Percent of top box distribution for room handed and satisfaction question relationship identified through Logistical regression analysis $p < .05$, n=4,615



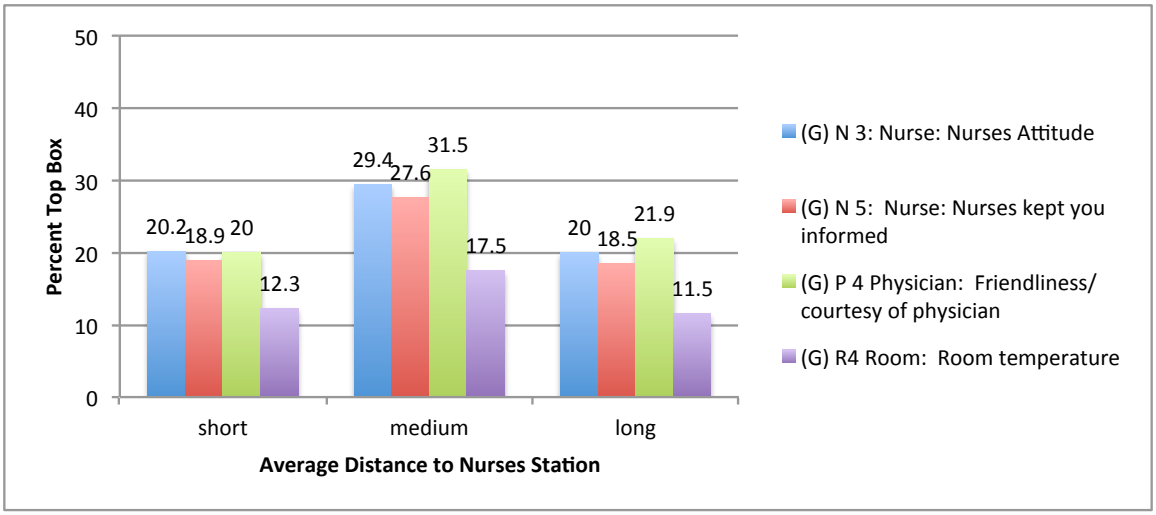
Three survey questions (R1 Room: Pleasantness of room décor, R2 Room: Room Cleanliness, R4 Room: Room temperature) were tied to room handedness. Right-handed rooms were found to have the highest percentage of top box scores on these three survey questions (Figure 6.14). The standard deviation on top box scores for right handed rooms ranged from 2.2-2.8%.

Figure 6-15 Percent of top box distribution for location of bed and satisfaction question relationship identified through Logistical regression analysis $p < 0.05$, n=4,615



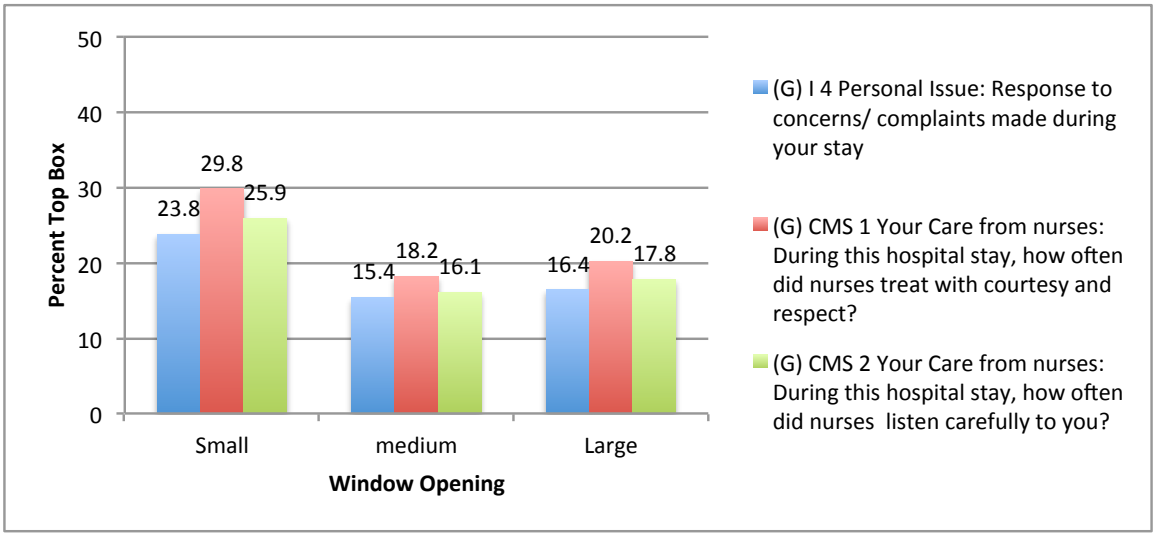
Location of the bed has been shown to be tied to two survey questions (R2 Room: Room Cleanliness and R4 Room: Room temperature) Rooms with the head of the bed located in the room were found to have the highest percentage of top box scores on these two survey questions (Figure 6.15). The standard deviation on top box scores for rooms with the head of the bed in the room ranged from 32.8-38.8%.

Figure 6-16 Percent of top box distribution for average distance to the nurses station and satisfaction question relationship identified through Logistical regression analysis *p* <.05, n=4,615



Average distance to the nurse's station was related to three survey questions: N3 Nurses Attitude, N5 Nurses kept you informed and P4 Physician: Friendliness/courtesy of physician (Figure 6.16). Rooms located at a medium distance from the nurse's station (36-70 lineal feet) were found to have the highest percentage of top box scores on these three survey questions. The standard deviation on top box scores for rooms located a medium distance from the nurse's station ranged from 8.7-9.6%.

Figure 6-17 Percent of top box distribution for window opening and satisfaction question relationship identified through Logistical regression analysis $p < .05$, n=4,615



Window opening was related to three survey questions: CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?, CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?, and I 4 Response to concerns/ complaints made during your stay (Figure 6.17). Rooms with small windows were found to have the highest percentage of top box scores on these three survey questions. The standard deviation on top box scores for rooms located a medium distance from the nurse's station ranged from 8.4-11.6%.

6.3. Discussion

This study's intent was to explore the possible relationships of the room layouts on patient self-reported outcome scores. The previous studies that have been conducted in these areas have looked at room aesthetics, such as enhanced rooms from renovations (Jha et al., 2008), but nothing has looked at the impact on how the environment may associate with the perceived behavior of staff in a space. Through careful, step-wise analysis, this study was able to show that there could be a plausible relationship to spatial variables identified, but the moderating variable effect was hard to determine.

Organizational cultural influences are one of the top moderators that were intended to control for in this study. Through careful analysis, the author has a concern that there may have been a cultural influencer that was moderating the outcomes. To begin, two of the five spatial variables that were selected (window size and location of the bed) had a direct tie to the unit, meaning there was little variance within unit for these two variables. In review of the unit performance, the E unit (2.5% rooms with a top box mean score) performs the best and the B unit performance the worst (.8% rooms with a top box mean score). As discussed earlier, the variation of window size was tied to the unit as well as the location of the bed. The location of first encounter had some variation by unit. The other two variables, room handedness and average distance to the nurse's station, were universally distributed and would be the greatest variation by unit. The author is most comfortable with the outcomes from the well-distributed spatial variable of room handedness and average distance to the nurse's station. A suggestion for further studies would be to explore additional spatial variables that are more evenly distributed throughout the units.

Not only the unit performance could be an influencer but the type of specialty may be an influencer as well. With the Press Ganey report (Appendix), the units and rooms that are included in this study vary in standard performance from best to worst in the Press Ganey overview. It needs to be noted that this could be a plausible association with the outcomes of the study. Additional analysis could be done with the outcomes if they are further sorted by the specialty group.

Patient characteristics were the other influencer and identified moderator. As has been shown in other studies (Hall Judith A., 1990; Rosenheck et al., 1997; Williams & Calnan, 1991), specific patient characteristics can be influencers as well. This is shown in the noted P values from the logistical regression analysis in table 6.19. The patient characteristics need to be noted as possible moderating variables in this study. The table shows that each patient self-reported outcome survey is tied directly to more than one of the identified patient characteristics. This is a limitation of the study, but a known influencer.

Table 6-19 Summary table of patient and spatial variables logistical regression p values. Showing the possible moderating variables.

	Patient Characteristic					Spatial Variable				
	Admit	Age	Gender	CMS 26 Rate of Mental health	CMS 25 rate of overall health	Average Distance to RN Station	Room Handed	location of Bed	window opening	location of first encounter
	P Value	P Value	P Value	P Value	P Value	P Value	P Value	P Value	P Value	P value
Dependent Satisfaction Variable										
N 3: Nurses Attitude	0.002	0.044	0.002	0.000	0.03	0.035				
N 5: Nurses kept you informed	0.003	0.000	0.001	0.000	0.024	0.037				
CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?	0.000			0.000	0.008				0.008	
CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?	0.000	0.015		0.000	0.023				0.009	
P 4 Physician: Friendliness/courtesy of physician		0.000	0.007	0.000	,018	0.034				
P 5: Skill of the physician	0.000	0.001	0.000	0.000	0.076					0.001
I 4 Personal Issue: Response to concerns/ complaints									0.008	
R 1 Room: Pleasantness of room décor	0.007			0.000	0.000	0.045	0.005			0.000
R 2 Room: Room Cleanliness			0.001	0.000	0.000		0.003	0.000		0.010
R 4 Room: Room temperature				0.000	0.001	0.018	0.019	0.000		0.000

Again, as an exploratory study, the intent was to show the plausible relationship of spatial layout to patient self-reported outcomes which is demonstrated through the analysis. The effect may be small, but there is a significance that has been tested on a large data set that was not influenced by an aesthetic room change. It is intriguing that the nursing and physician survey questions were tied to the more evenly distributed spatial variables of average distance to the nurse's station, room handedness, and possibly the location of first encounter.

While the room aesthetics were deliberately not explored here, it is intriguing to see that there is a strong relationship between spatial layouts to the patient self-reported outcome questions of a pleasant room (R1, R2, R4). This relationship generates interest to further test that there may be universally appealing room layouts. Could it be that patients have a preferred distance they like to be from a nurse's station and a preferred orientation of staff when they enter the room to wash their hands?

Section 3. Integrated Discussion

This study has methodologically identified and defined key variables and explored the possible relationships these variables have to each other through a series of statistical test in two field studies. The intent of this careful and rigorous review is to demonstrate that the built environment and more specifically the five identified spatial variables (window opening, room handed, location of bed, distance to the nurse station, and location of first encounter) do associate with the patients' experience of care through the self-reported outcome of patient satisfaction and HCAHPS questions.

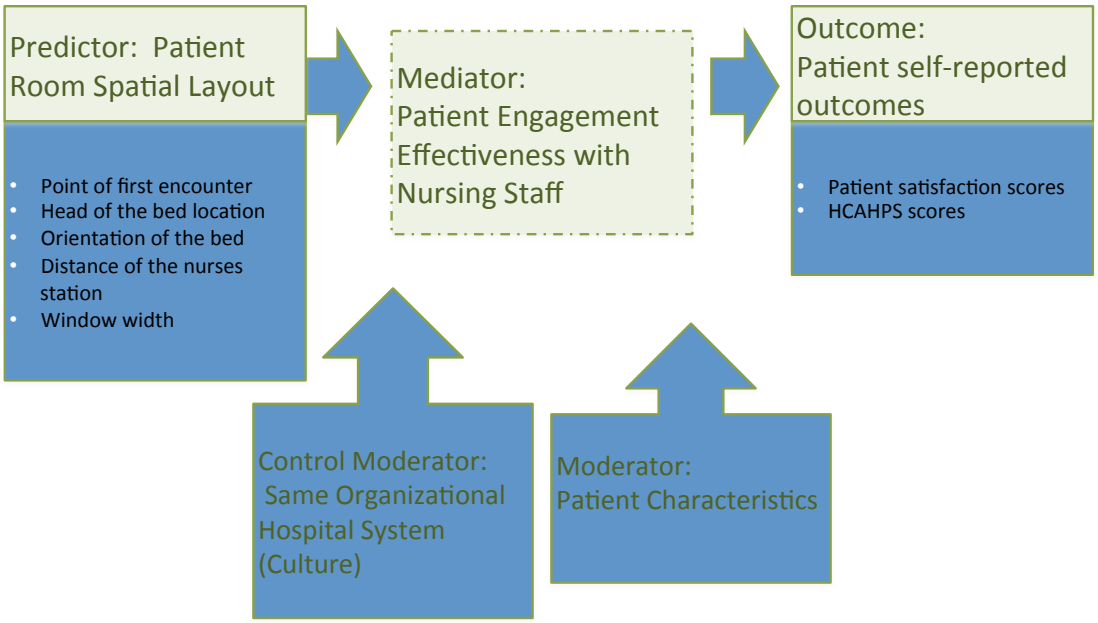
In this section the intent is to summarize the findings from the two field studies and identify the significant findings as well as note the limitations and possible future study opportunities.

7. Conclusion

7.1. Summary comparison of field study findings

The two research studies in this paper provide two separate sources of data of spatial layout to patient self-reported outcomes with the same cultural moderators controlled or tested for significance. In review of the findings it is established that there is a statistically significant relationships between the independent variable (spatial layout) and dependent variable (patient satisfaction). While this is not a causal research study ,using the causal model as a framework (Figure 7.1) has afforded the plausible association of the two variables. In summarizing the finding of the possible predictor variables and the identified moderating variables it is demonstrated that the building environment, in particular, key spatial variable are statistically significantly related to certain patient self reported outcomes.

Figure 7-1 Overall causal model that represents the framework for this research study. This study examines the relationship of patient satisfaction and spatial layout. The mediators and moderated noted for study in future work.



Fourteen of the 40 possible questions analyzed were found to be statistically significant related to the five spatial variables (window opening, room handed, location of bed, distance to the nurse station, and location of first encounter $(p < 0.05)$. These questions (Table 7.1) were primarily from the Press Ganey survey and included three from nursing (N1,N3,N5), physician (P1, P4, P5), individual (I1, I3, I4) and room perspective (R1, R2, R4). Two questions were found to be statistically significant from the HCAHPS survey both focused around nursing care (CMS1 and 2). While these findings were significant it was also noted that the moderator of patient characteristics were also found to be statistically significant in both field studies in 10 of the 14 questions. These questions were from the Press Ganey survey in the areas of the individual (I1, I3, I4) and the physician (P1). Therefore, this study has demonstrated that certain spatial

variables are associated with patient self-reported outcomes specifically Press Ganey satisfaction scores.

Table 7-1 List of statistically significant ($p < 0.05$) survey questions from Press Ganey and HCAHPS that are related to five identified spatial variables (window opening, room handedness, head of the bed location, distance to the nurse station, and location of first encounter).

	Spatial Variables	average distance to RN station	room handed	location of Bed	window opening	location of first encounter
	Highest Performing Categorical Spatial Variable	mid point (36-70) Lineal feet	Right handed rooms	Bed located within the room	Small window opening	Facing the patient
Dependent Satisfaction Variable						
NURSE	N1 Nurses: Friendliness/ courtesy of the nurse					Preliminary
	N3: Nurses: Nurses Attitude	General Only				
	N 5: Nurses: Nurses kept you informed	General				
	CMS 1 Your Care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect?				General Only	
	CMS 2 Your Care from nurses: During this hospital stay, how often did nurses listen carefully to you?				General Only	
PHYSICIAN	P1 Physician: physician's concern for your question and worries		Preliminary			
	P4 Physician: Friendliness/courtesy of physician	General				
	P5: Physician: skill of the physician		Preliminary			Preliminary / General
PERSONAL ISSUE	I 1 Personal Issue: Staff concern for your privacy					Preliminary
	I 3 Personal Issue: How well was your pain controlled		Preliminary			
	I 4 Personal Issue: Response to concerns/ complaints made during your stay				Preliminary / General	
ROOM	R1 Room: Pleasantness of room décor	General Only	General Only			General Only
	R2 Room: Room cleanliness		General Only	General Only		General Only
	R4 Room: Room temperature	General	General	Preliminary / General		Preliminary / General

This study's findings show the plausible associate with of the spatial variable identified to patients self-reported outcomes, as well as, identify what has been discussed as room performance by spatial type. An unintended outcome of the exploration of the relationship of the spatial variable and patient self-reported outcome variable was that certain spatial room categories were out-performing the other categories for most of the questions that were found to be statistically related. This outcome is critical to explore as the scores that were evaluated were

"top box" score. Again the definition of "top box" is scores of 100%. This means a variation of just 1% of the top box score can move an organization performance from the 75th percentile to the 90th percentile (Table 7.2). As was discussed in Chapter One of this study, the "value of care" is translated to reimbursement dollars for the healthcare provider. The reimbursement dollars are calculated through a complicated analysis which could be a topic for further research. It is notable in Table 7.2 that a slight modification on the "top box" performance ranking of the hospital system can change the ranking and be translated to substantial reimbursement dollars. Therefore, all variables of association on the survey outcomes need to be fully considered – this includes the patient characteristics, service quality and the built environment.

Table 7-2 Average mean score by specialty to increase ranking and overall performance by service line. (Table courtesy of Redge Hanna 2014 (Hanna, 2014))

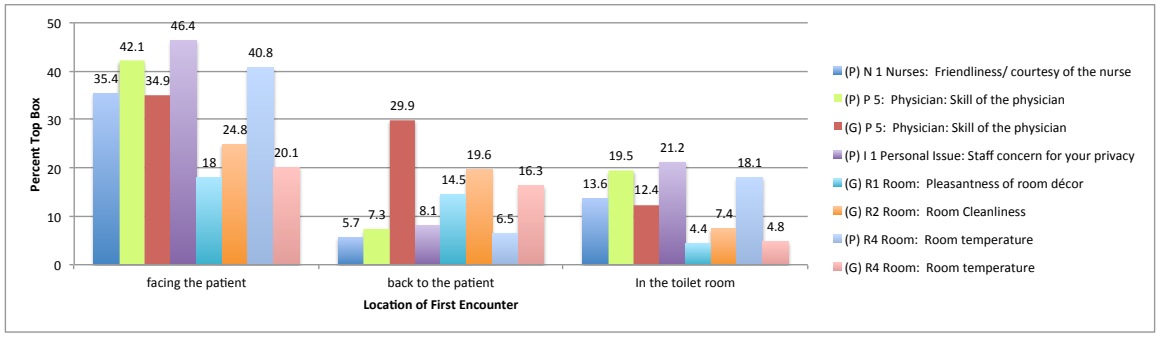
	Mean Needed for Following Rankings				
	10th	25th	50th	75th	90th
Inpatient	82.1	84.3	86.5	88.1	89.4
ED	76.5	80.4	84.8	87.5	89.8
Outpatient	88.8	91.2	92.3	93.2	94.2
Ambulatory Surgery	88.5	90.6	92.3	93.4	94.5
Medical Practice	78.2	86.2	89.2	90.8	92.3

The next section will discuss each categorical spatial variable (window opening, room handed, location of bed, distance to the nurse station, and location of first encounter) the statistically significant findings ($p < 0.05$) from each field study and perceived performance variation of the variable. As is noted above an unintended finding of the studies are that every spatial variable has an association with at least satisfaction question, making for an interesting future research to explore ideal design guidelines for improved performance ($p < 0.05$).

Location of First Encounter: The location of the first encounter in the patient's room has been identified as an important spatial element that allows the gaze of the staff member to easily engage with the patient upon first entering the room. It was assumed that the rooms with

the hand wash sink facing the patient would be the higher performing room based on previous research. Both studies found a statistical significant relationship to the location of first encounter and five Press Ganey satisfaction questions (Figure 7.2). Two of the room related questions (R1 pleasantness p=0.000, R2 cleanliness p=0.010), one nurse related question (N1 friendliness/ courtesy of the nurse p=0.00), one individual question (I1 staff concern for your privacy p=0.004) and one physician related question (P5 skill of physician p=0.003). In both studies the categorical variable "facing" (facing, back, in) is found at a higher rate by 60% (preliminary) and 46% (general) with the majority of the "facing" rooms on the G unit. The rooms that had sinks that allowed the practitioner to face the patient upon first encounter of the inpatient rooms are the higher performing rooms (5% general and 22% preliminary) for the five statically significant questions. The "facing" rooms were anticipated to be the higher performing outcomes . It is noted that there were patient characteristic that could be moderating the findings with statistically significant relationships ($p < 0.05$) to all of the survey questions expect for the one Individual related question (I1 staff concern for your privacy). Therefore, this spatial variable was found to be statically significantly related to I1 staff concern for your privacy with no know moderating variables.

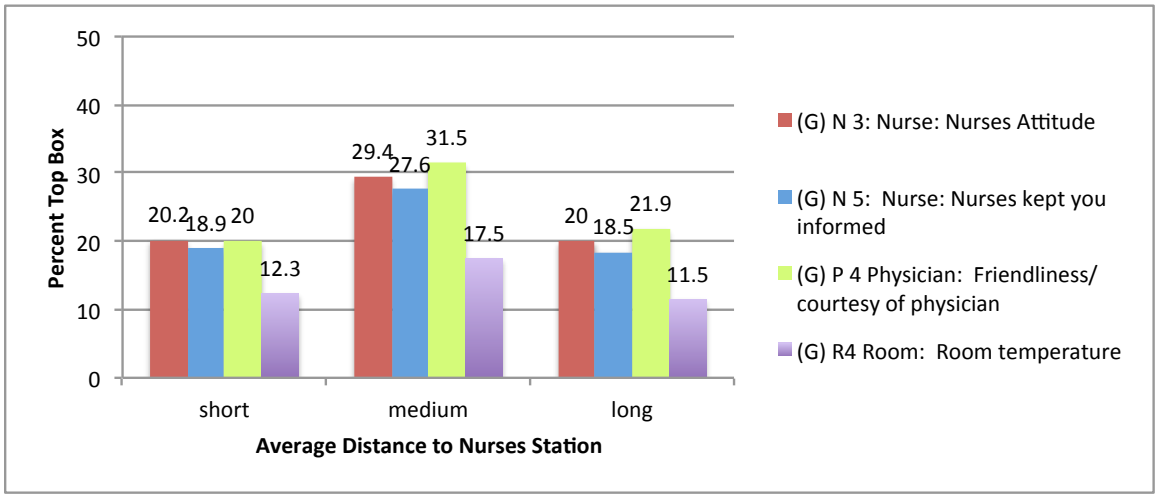
Figure 7-2 Descriptive table showing the actual percent of top box distribution for location of first encounter and satisfaction question statistically significant relationship p <.05, (G)n=4,615, (P)n=3,751



Distance to the Nurses Station: This study's data showed in Figure 7.3 a statistical significant relationship to the distance to the nurse's station and three Press Ganey satisfaction questions ($p < 0.05$). Two of the nursing related questions (N3 attitude p=0.035 and N5 kept you

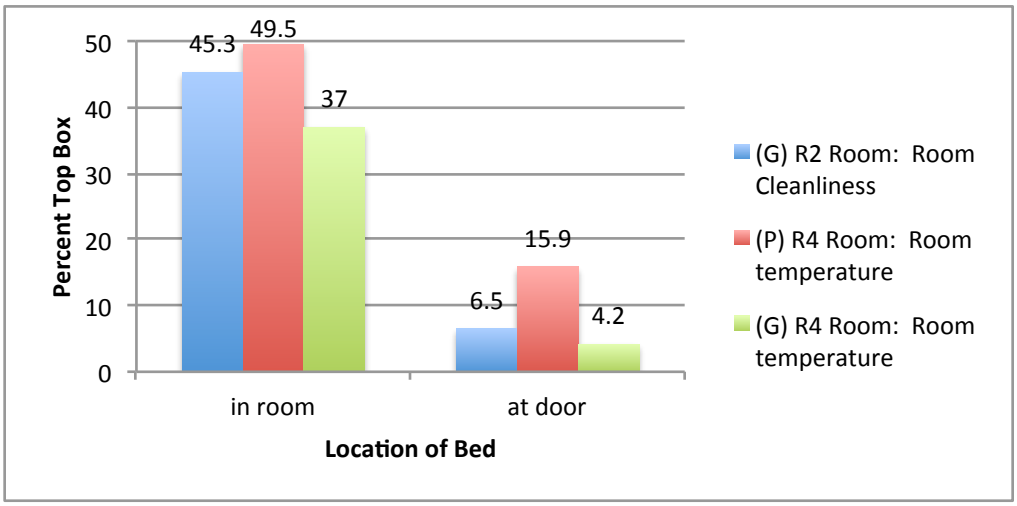
informed p=0.037) and one physician related question (P4 physician kept you informed p=0.034). The distribution of the three spatial categorical variables (1-35 lineal feet is short, 36-70 lineal feet is medium, and 71 lineal feet and greater for long) is relatively evenly distributed over the three units where the majority of the rooms are located at the midpoint of 36-70 lineal feet. The "midpoint" rooms are also the higher performing rooms (10%) for the three statically significant questions. This finding supported the notion that the higher performing rooms would be mid way from the nurses station. It is noted that there were patient characteristic that could be moderating the findings with statically significant relationships to the three question for all five patient characteristics explored ($p < 0.05$). Therefore, the findings may be influenced by the patient characteristics (admissions type, age, gender, rate of mental health and rate overall health). It should also be noted that there were no statistically significant relationships found in the preliminary field study – all findings were identified in the general field study. While there may be moderating variables influencing the outcome it seems plausible that satisfaction questions N5 nurse kept you informed, and P4 physician kept you informed could be related to the distance to the nurse station as there may be an ideal distance to easefully keep a patient informed. This could be explored in a future study.

Figure 7-3 Descriptive table showing the actual percent of top box distribution for average distance to the nurses station and satisfaction question statistically significant relationship p <.05, (G)n=4,615, (P)n=3,751



Location of Bed: The general study showed a statistically significant relationship to the location of bed and two room related satisfaction questions from the Press Ganey around R2 cleanliness (p=0.003) and R4 temperature (p=0.000). The majority of the rooms in the general field study had the bed placed within the room at 86%. The distribution of the within room bed category (head of the bed in the room and head of the bed at the door) was relatively evenly distributed by the units with the exception of unit B which has less rooms (10%). The "in bed" rooms were also the higher performing rooms (33-39%) for the two statically significant questions ($p < 0.05$). This finding was the assumed direction that would perform at the higher level . It is noted that there were patient characteristic that could be moderating the findings with statically significant relationships to the nursing question to four of the patient characteristics ($p < 0.05$). Age of the patient was not an influencer (admissions type, gender, rate of mental health and rate overall health). Therefore, the findings may be influenced by the patient characteristics. It should also be noted that there were no relationships found in the preliminary field study all finding were found within the general field study. While there may be moderating variables influencing the outcome it seems plausible that satisfaction questions R2 room cleanliness (p=0.003), and R4 room temperature (p=0.000) could be related to the location of the bed. This is because rooms at the door could receive different air movement as well as provide more visual distractions and clutter that could be seen in the corridor. This could be a topic for further research exploration.

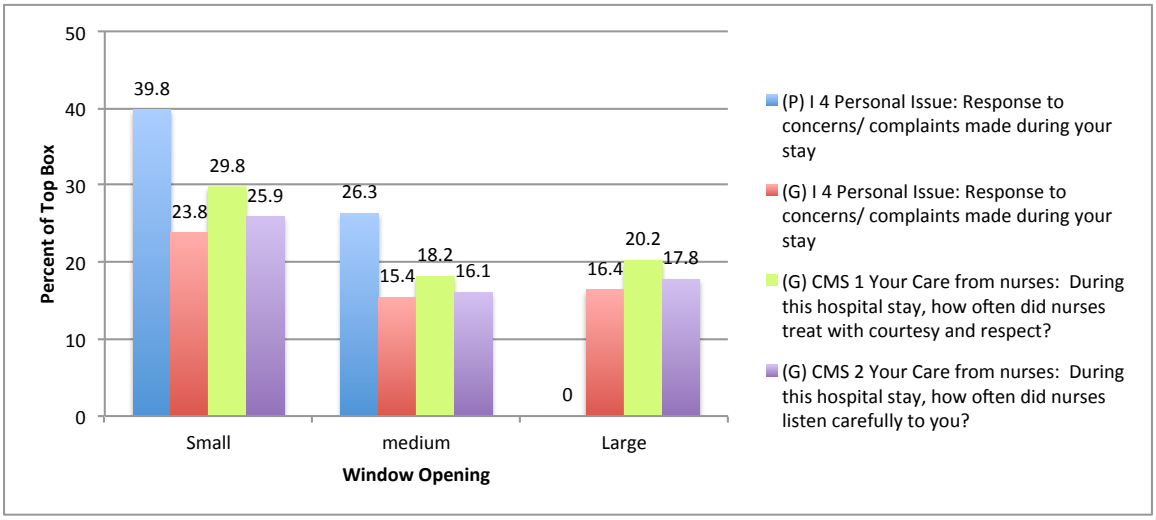
Figure 7-4 Descriptive table showing the actual percent of top box distribution for location of bed and satisfaction question statistically significant relationship $p < .05$, (G)n=4,615, (P)n=3,751



Window opening: Ulrich (1984) identified the importance of windows and views as an outcome for reduced pain and stress of a patient. The spatial variable of window opening was explored in this study (Figure 7.5). It was found that window opening was statically significantly related to one Press Ganey Satisfaction question (I 4 response to concerns/complaints made during your stay p=0.00) as well as two HCAHPS questions (CMS 2 your care from nurses: During this hospital stay, how often did nurses listen carefully to you? p=0.008 and CMS 1 your care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect? p=0.009). The distribution of the three categorical spatial variables (less than 5 lineal feet is small, 5 to 10 lineal feet is medium, 11 lineal feet and over is large) is not evenly distributed with the small window category entirely on the G unit. This lack of even distribution is a concern, as the findings could be influenced by the culture of that unit. The small window openings below 5 feet are also the higher performing rooms (14%-8%) for the three statically significant questions ($p < 0.05$). It is noted that there were patient characteristics (admissions type, age, gender, rate of mental health and rate overall health) that could be moderating the findings with statically significant relationships to the satisfaction questions ($p < 0.05$). Therefore, the findings may be influenced by the patient characteristics or also unit culture as identified moderators in the model framework creating an uncertainty with the significance in the finding of this variable. It is

plausible to interpret the findings of the spatial variable possibly that larger windows may not significantly impact the patient perception of care. This could be further explored in further studies.

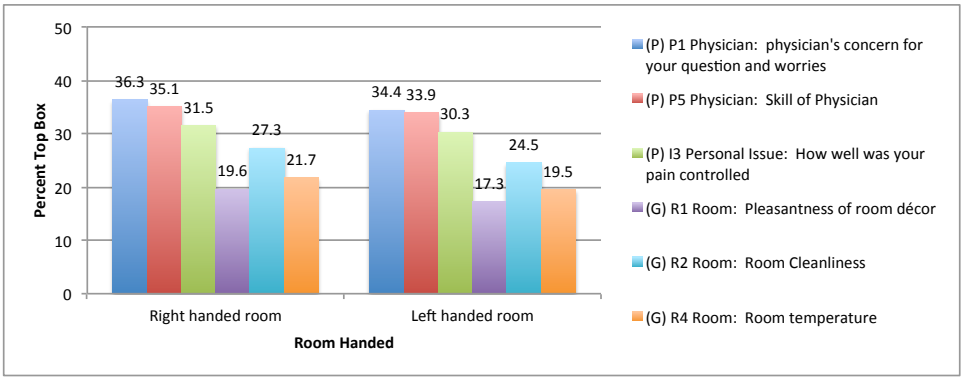
Figure 7-5 Descriptive table showing the actual percent of top box distribution for window opening and satisfaction question statistically significant relationship $p < .05$, (G)n=4,615, (P)n=3,751



Room Handedness: Room handedness, did show a statistical significant relationship in both field studies to six Press Ganey satisfaction questions (Figure 7.6). Two of the physician related questions (P1 physician concern for your question and worries p=0.018 and P5 skill of the physician p=0.003), three room related questions (R1 pleasantness of the room décor p=0.005, R2 cleanliness p=0.003, R4 temperature p=0.019), and one individual related question (I3 how well was your pain controlled p=0.028). The distribution of the two spatial variables (right and left) is relatively evenly distributed over the three units where the majority of the rooms are left handed(53%) this is the patients' left side is by the entry door. The right-handed rooms are higher performing rooms (1-3%) for the six statically significant questions. This is the only spatial variable in the study that did not categorical performance match the distribution of the surveys. Meaning the left-handed room represented the larger population but were the lower performing categorical variable. It is noted that patient characteristics of gender and health were found to be statically significantly related to the room related questions (R1 pleasantness of the room décor

p=0.005, R2 cleanliness *p*=0.003, R4 temperature *p*=0.019). Therefore, the findings may be influenced by the patient characteristics for the room related questions. Unique to any of the other spatial variables the room handed variable was relatively evenly distributed throughout the units and there were no know moderating variables for the two physician related questions (P1 physician concern for your question and worries *p*=0.018 and P5 skill of the physician *p*=0.003), and individual related question (I3 how well was your pain controlled *p*=0.028). Therefore it is plausible that right-handed rooms could improve the physician related scores as well as perceived pain of the patient. In discussion with clinicians one plausible reason why the right-handed rooms statistically perform better for physicians is that they are trained to address the patient from their right-side. This means that the physician may have a more easeful discussion at the patients right side then form the patients left-side. This relationship could be a topic of further discussion and exploration.

Figure 7-6 Descriptive table showing the actual percent of top box distribution for room handed and satisfaction question statistically significant relationship *p* <.05, (G)n=4,615, (P)n=3,751



In summary, inpatient rooms at Emory University Hospital the rooms with the location of first encounter, facing the patient, are associated to five Press Ganey questions *(p* < 0.05), making the "facing" rooms higher performing by approximately 5% general study (P5 skill of physician *p*=0.001, R1 pleasantness of the room décor *p*=0.000, R2 room cleanliness *p*=0.010) and 22% preliminary research study (N1 friendliness and courtesy of the nurse *p*=0.000, I1 staff concern for your privacy *p*=0.004) for all five questions.

The rooms with beds located within the room are associated to two Press Ganey question, making the within the room beds higher performing by at least 33% for both questions R2 room cleanliness (p=0.000), and R4 room temperature (p=0.000).

Rooms that are at the midpoint of a patient unit are statistically significantly related to three Press Ganey questions ($p < 0.05$). The midpoint rooms higher performing by 10% for all three questions N3 nurse attitude (p=0.035), N5 nurse kept you informed (p=0.037), and P4 physician kept you informed (p=0.034).

Rooms that are right-handed are associated to six Press Ganey questions, making the right-handed rooms higher performing by 1-3% for survey questions R1 pleasantness of the room décor (p=0.005), R2 cleanliness (p=00.3), R4 temperature (p=0.019), P1 Physician concern for your question and worries (p=0.018), P5 skill of the physician (p=0.003), and I3 how well was your pain controlled (p=0.028).

Rooms with small windows are associated to three Press Ganey questions. The midpoint rooms higher performing by 10% for all three questions (I 4 response to concerns/ complaints made during your stay p=0.000, CMS 2 your care from nurses: During this hospital stay, how often did nurses listen carefully to you? p=0.009 and CMS 1 your care from nurses: During this hospital stay, how often did nurses treat with courtesy and respect? p=0.008).

The overall intent of the study was to demonstrate that architectural spatial variables can plausibly influence the patients' self-reported outcomes through this studies noted associations of the spatial variables and satisfaction outcomes. While further analysis should be completed, it is clearly demonstrated in both studies. Another outcome from these studies is that the possible spatial categorical variables that have a plausible higher performance. The high performing spatial categories have the bed located within the room with the patient's right side facing the entry door and the hand wash sink facing the patient with a small window (5 feet or less) opening at the mid point of the corridor (36-70 lineal feet).

7.2. Limitations

This is a comprehensive study of many variables and systems. There are limitations that are worth noting. This is a retrospective study using hospital provided patient self reported outcome survey scores. While patient characteristics were linked to each survey, there are other potential moderating variables not included in that data set. For example, there is no staffing information that identified number of time the patient was seen or what and how care was delivered. These variables could possibly moderate the outcome but could only be inferred by the designation of the unit or floor of the hospital in the study.

In Chapter three all spatial variables are explored to be included in this research study. It is noted that two of the selected five spatial variables are not evenly distributed across all the rooms in the study. The window opening, and location of the bed are more tied to the specific unit characteristics. This relationship to the unit creates a stronger relationship to organizational culture moderator. The outcomes using these two variables may have other moderating influencers by staff and their operations in the statistical findings.

The number of variables could have a negative affect on the statistical outcomes. There was over 43 satisfaction questions explored and 8,366 patient surveys reviewed for this study, creating approximately 360,000 individual scores. The intention of the preliminary study was to leave all 360,000 surveys independent and to analyze them individually to further explore what validation could be done with dimension reduction analysis.

This study uses two separate data sources from two different years. The variation of the population could be an influence of the outcomes.

Further work needs to be completed on the associate of window size to the patients self-reported outcome. Looking to other facilities that have varying window openings may inform the plausible relationship to the patient's self-reported outcome.

7.3. Future work

Throughout this research study there were many opportunities noted for further research as this was an exploratory study. The list below are the most promising opportunities for further work.

- As identified in the literature review spatial variable were identified through their previous significance in other research studies. There are other spatial variable that could be explored using a similar method to further identify additional variables of significance.
- Additional work needs to be done to show the relationship of spatial layout, visual interaction, and co-presence to room performance. This is noted in the dashed box of the causal framework (Figure 7.1).
- Within the exploration of the average distance to the nurses station there could be a further exploration of the ideal distance for keeping a patient informed (N5 nurse kept you informed, and P4 physician kept you informed). With the findings in this study that demonstrated rooms at the midpoint of the unit had higher scores in the question of being kept informed is there an ideal state for this distance?
- Bed location at the door may have an effect on the patient's perception of the room. Further exploration of the visibility difference from patient's perception could be explored to further identify the possible influencers.

7.4. Research Contributions

This retrospective research study contribute to the ongoing efforts to identify associations of the patient self-reported outcomes specifically patient satisfaction and HCAHPS scores. The goal of this study is not to confirm a causal relationship between satisfaction outcome and spatial variables but instead to explore the relationship to see if it is plausible. It identifies that spatial variables are statistically significantly related to 14 survey questions and ultimately can be associated with "top box" performance placing the built environment and a known variable of association in the field of patient satisfaction. This study also identifies possible high performing

categorical spatial variables that statically demonstrate higher performance over the other variables.

Along with the finding discussed above, this study also begins to establish a rigorous method to explore the effects of the built environment on a persons' perception of care, or self-reported outcomes. This is one of the first rigorous research studies looking to connect the spatial associations to the perceived care behavior. There are studies that look at aesthetic qualities (Jha et al., 2008) but none that look at the environment as a mode to enhance the care delivery.

Appendix A: HCAHPS Sample Survey

HCAHPS Survey

SURVEY INSTRUCTIONS

- You should only fill out this survey if you were the patient during the hospital stay named in the cover letter. Do not fill out this survey if you were not the patient.
- Answer all the questions by checking the box to the left of your answer.
- You are sometimes told to skip over some questions in this survey. When this happens you will see an arrow with a note that tells you what question to answer next, like this:

  ☐ Yes
  ☑ No ➔ ***If No, Go to Question 1***

You may notice a number on the survey. This number is used to let us know if you returned your survey so we don't have to send you reminders.
Please note: Questions 1-25 in this survey are part of a national initiative to measure the quality of care in hospitals. OMB #0938-0981

Please answer the questions in this survey about your stay at the hospital named on the cover letter. Do not include any other hospital stays in your answers.

YOUR CARE FROM NURSES

1. During this hospital stay, how often did nurses treat you with courtesy and respect?

[1]☐ Never
[2]☐ Sometimes
[3]☐ Usually
[4]☐ Always

2. During this hospital stay, how often did nurses listen carefully to you?

[1]☐ Never
[2]☐ Sometimes
[3]☐ Usually
[4]☐ Always

3. During this hospital stay, how often did nurses explain things in a way you could understand?

[1]☐ Never
[2]☐ Sometimes
[3]☐ Usually
[4]☐ Always

4. During this hospital stay, after you pressed the call button, how often did you get help as soon as you wanted it?

[1]☐ Never
[2]☐ Sometimes
[3]☐ Usually
[4]☐ Always
[9]☐ I never pressed the call button

YOUR CARE FROM DOCTORS

5. During this hospital stay, how often did doctors treat you with courtesy and respect?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

6. During this hospital stay, how often did doctors listen carefully to you?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

7. During this hospital stay, how often did doctors explain things in a way you could understand?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

THE HOSPITAL ENVIRONMENT

8. During this hospital stay, how often were your room and bathroom kept clean?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

9. During this hospital stay, how often was the area around your room quiet at night?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

YOUR EXPERIENCES IN THIS HOSPITAL

10. During this hospital stay, did you need help from nurses or other hospital staff in getting to the bathroom or in using a bedpan?

1☐ Yes
2☐ No ➔ **If No, Go to Question 12**

11. How often did you get help in getting to the bathroom or in using a bedpan as soon as you wanted?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

12. During this hospital stay, did you need medicine for pain?

1☐ Yes
2☐ No ➔ **If No, Go to Question 15**

13. During this hospital stay, how often was your pain well controlled?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

14. During this hospital stay, how often did the hospital staff do everything they could to help you with your pain?

1☐ Never
2☐ Sometimes
3☐ Usually
4☐ Always

15. During this hospital stay, were you given any medicine that you had not taken before?

[1] ☐ Yes
[2] ☐ No ➔ **If No, Go to Question 18**

16. Before giving you any new medicine, how often did hospital staff tell you what the medicine was for?

[1] ☐ Never
[2] ☐ Sometimes
[3] ☐ Usually
[4] ☐ Always

17. Before giving you any new medicine, how often did hospital staff describe possible side effects in a way you could understand?

[1] ☐ Never
[2] ☐ Sometimes
[3] ☐ Usually
[4] ☐ Always

WHEN YOU LEFT THE HOSPITAL

18. After you left the hospital, did you go directly to your own home, to someone else's home, or to another health facility?

[1] ☐ Own home
[2] ☐ Someone else's home
[3] ☐ Another health facility ➔ **If Another, Go to Question 21**

19. During this hospital stay, did doctors, nurses or other hospital staff talk with you about whether you would have the help you needed when you left the hospital?

[1] ☐ Yes
[2] ☐ No

20. During this hospital stay, did you get information in writing about what symptoms or health problems to look out for after you left the hospital?

[1] ☐ Yes
[2] ☐ No

OVERALL RATING OF HOSPITAL

Please answer the following questions about your stay at the hospital named on the cover letter. Do not include any other hospital stays in your answers.

21. Using any number from 0 to 10, where 0 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?

[0] ☐ 0 Worst hospital possible
[1] ☐ 1
[2] ☐ 2
[3] ☐ 3
[4] ☐ 4
[5] ☐ 5
[6] ☐ 6
[7] ☐ 7
[8] ☐ 8
[9] ☐ 9
[10] ☐ 10 Best hospital possible

22. Would you recommend this hospital to your friends and family?

[1] ☐ Definitely no
[2] ☐ Probably no
[3] ☐ Probably yes
[4] ☐ Definitely yes

UNDERSTANDING YOUR CARE WHEN YOU LEFT THE HOSPITAL

23. During this hospital stay, staff took my preferences and those of my family or caregiver into account in deciding what my health care needs would be when I left.

[1] ☐ Strongly disagree
[2] ☐ Disagree
[3] ☐ Agree
[4] ☐ Strongly agree

24. When I left the hospital, I had a good understanding of the things I was responsible for in managing my health.

[1] ☐ Strongly disagree
[2] ☐ Disagree
[3] ☐ Agree
[4] ☐ Strongly agree

25. When I left the hospital, I clearly understood the purpose for taking each of my medications.

[1] ☐ Strongly disagree
[2] ☐ Disagree
[3] ☐ Agree
[4] ☐ Strongly agree
[5] ☐ I was not given any medication when I left the hospital

ABOUT YOU

There are only a few remaining items left.

26. During this hospital stay, were you admitted to this hospital through the Emergency Room?

[1] ☐ Yes
[2] ☐ No

27. In general, how would you rate your overall health?

[1] ☐ Excellent
[2] ☐ Very good
[3] ☐ Good
[4] ☐ Fair
[5] ☐ Poor

28. In general, how would you rate your overall mental or emotional health?

[1] ☐ Excellent
[2] ☐ Very good
[3] ☐ Good
[4] ☐ Fair
[5] ☐ Poor

29. What is the highest grade or level of school that you have completed?

[1] ☐ 8th grade or less
[2] ☐ Some high school, but did not graduate
[3] ☐ High school graduate or GED
[4] ☐ Some college or 2-year degree
[5] ☐ 4-year college graduate
[6] ☐ More than 4-year college degree

30. Are you of Spanish, Hispanic or Latino origin or descent?

[1] ☐ No, not Spanish/Hispanic/Latino
[2] ☐ Yes, Puerto Rican
[3] ☐ Yes, Mexican, Mexican American, Chicano
[4] ☐ Yes, Cuban
[5] ☐ Yes, other Spanish/Hispanic/Latino

31. What is your race? Please choose one or more.

[1] ☐ White
[2] ☐ Black or African American
[3] ☐ Asian
[4] ☐ Native Hawaiian or other Pacific Islander
[5] ☐ American Indian or Alaska Native

32. What language do you <u>mainly</u> speak at home?

[1] ☐ English
[2] ☐ Spanish
[3] ☐ Chinese
[4] ☐ Russian
[5] ☐ Vietnamese
[6] ☐ Portuguese
[9] ☐ Some other language (please print): _____

THANK YOU

Please return the completed survey in the postage-paid envelope.

[NAME OF SURVEY VENDOR OR SELF-ADMINISTERING HOSPITAL]

[RETURN ADDRESS OF SURVEY VENDOR OR SELF-ADMINISTERING HOSPITAL]

Appendix B: Emory Press Ganey Sample Survey

EMORY
UNIVERSITY
HOSPITAL

OMB Control Number: 0938-0981

SURVEY INSTRUCTIONS: You should only fill out this survey if you were the patient during the hospital stay named in the cover letter. Do not fill out this survey if you were not the patient. Answer all the questions by completely filling in the circle to the left of your answer. You are sometimes told to skip over some questions in this survey. When this happens you will see an arrow with a note that tells you what question to answer next, like this: ○ Yes
● No → **If No, Go to Question 1**

Please answer the questions in this survey about your stay at Emory University Hospital. Do not include any other hospital stays in your answers.

Please use black or blue ink to fill in the circle completely.
Example: ●

YOUR CARE FROM NURSES

1. During this hospital stay, how often did nurses treat you with courtesy and respect?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

2. During this hospital stay, how often did nurses listen carefully to you?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

3. During this hospital stay, how often did nurses explain things in a way you could understand?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

4. During this hospital stay, after you pressed the call button, how often did you get help as soon as you wanted it?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always
   ○ I never pressed the call button

YOUR CARE FROM DOCTORS

5. During this hospital stay, how often did doctors treat you with courtesy and respect?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

6. During this hospital stay, how often did doctors listen carefully to you?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

7. During this hospital stay, how often did doctors explain things in a way you could understand?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

THE HOSPITAL ENVIRONMENT

8. During this hospital stay, how often were your room and bathroom kept clean?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

9. During this hospital stay, how often was the area around your room quiet at night?
   ○ Never
   ○ Sometimes
   ○ Usually
   ○ Always

YOUR EXPERIENCES IN THIS HOSPITAL

10. During this hospital stay, did you need help from nurses or other hospital staff in getting to the bathroom or in using a bedpan?
    ○ Yes
    ○ No → **If No, Go to Question 12**

11. How often did you get help in getting to the bathroom or in using a bedpan as soon as you wanted?
    ○ Never
    ○ Sometimes
    ○ Usually
    ○ Always

12. During this hospital stay, did you need medicine for pain?
    ○ Yes
    ○ No → **If No, Go to Question 15**

continued...

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13. During this hospital stay, how often was your pain well controlled?
    - O Never
    - O Sometimes
    - O Usually
    - O Always

14. During this hospital stay, how often did the hospital staff do everything they could to help you with your pain?
    - O Never
    - O Sometimes
    - O Usually
    - O Always

15. During this hospital stay, were you given any medicine that you had not taken before?
    - O Yes
    - O No → **If No, Go to Question 18**

16. Before giving you any new medicine, how often did hospital staff tell you what the medicine was for?
    - O Never
    - O Sometimes
    - O Usually
    - O Always

17. Before giving you any new medicine, how often did hospital staff describe possible side effects in a way you could understand?
    - O Never
    - O Sometimes
    - O Usually
    - O Always

WHEN YOU LEFT THE HOSPITAL

18. After you left the hospital, did you go directly to your own home, to someone else's home, or to another health facility?
    - O Own home
    - O Someone else's home
    - O Another health facility → **If Another, Go to Question 21**

19. During this hospital stay, did doctors, nurses or other hospital staff talk with you about whether you would have the help you needed when you left the hospital?
    - O Yes
    - O No

20. During this hospital stay, did you get information in writing about what symptoms or health problems to look out for after you left the hospital?
    - O Yes
    - O No

OVERALL RATING OF HOSPITAL

Please answer the following questions about your stay at the hospital named on the cover letter. Do not include any other hospital stays in your answers.

21. Using any number from 0 to 10, where 0 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?
    - O 0 Worst hospital possible
    - O 1
    - O 2
    - O 3
    - O 4
    - O 5
    - O 6
    - O 7
    - O 8
    - O 9
    - O 10 Best hospital possible

22. Would you recommend this hospital to your friends and family?
    - O Definitely no
    - O Probably no
    - O Probably yes
    - O Definitely yes

UNDERSTANDING YOUR CARE WHEN YOU LEFT THE HOSPITAL

23. During this hospital stay, staff took my preferences and those of my family or caregiver into account in deciding what my health care needs would be when I left.
    - O Strongly disagree
    - O Disagree
    - O Agree
    - O Strongly agree

24. When I left the hospital, I had a good understanding of the things I was responsible for in managing my health.
    - O Strongly disagree
    - O Disagree
    - O Agree
    - O Strongly agree

25. When I left the hospital, I clearly understood the purpose for taking each of my medications.
    - O Strongly disagree
    - O Disagree
    - O Agree
    - O Strongly agree
    - O I was not given any medication when I left the hospital

123456789

SAMPLE

ABOUT YOU

26. During this hospital stay, were you admitted to this hospital through the Emergency Room?
    - O Yes
    - O No

27. In general, how would you rate your overall health?
    - O Excellent
    - O Very good
    - O Good
    - O Fair
    - O Poor

28. In general, how would you rate your overall mental or emotional health?
    - O Excellent
    - O Very good
    - O Good
    - O Fair
    - O Poor

29. What is the highest grade or level of school that you have completed?
    - O 8th grade or less
    - O Some high school, but did not graduate
    - O High school graduate or GED
    - O Some college or 2-year degree
    - O 4-year college graduate
    - O More than 4-year college degree

30. Are you of Spanish, Hispanic or Latino origin or descent?
    - O No, not Spanish/Hispanic/Latino
    - O Yes, Puerto Rican
    - O Yes, Mexican, Mexican American, Chicano
    - O Yes, Cuban
    - O Yes, other Spanish/Hispanic/Latino

31. What is your race? Please choose one or more.
    - O White
    - O Black or African American
    - O Asian
    - O Native Hawaiian or other Pacific Islander
    - O American Indian or Alaska Native

32. What language do you mainly speak at home?
    - O English
    - O Spanish
    - O Chinese
    - O Russian
    - O Vietnamese
    - O Portuguese
    - O Some other language (please print): _____

ADDITIONAL QUESTIONS ABOUT YOUR STAY

Now that we have asked you to tell us about *what happened* during your stay, we want to ask you about how well we *met your needs*.

INSTRUCTIONS: Fill in the circle that best describes your experience. If a question does not apply to you, please skip to the next question. Space is provided for you to comment on your experiences.

ADMISSION/REGISTRATION	very poor 1	poor 2	fair 3	good 4	very good 5
1. Speed of admission/registration process	O	O	O	O	O
2. Courtesy of the person who admitted/registered you	O	O	O	O	O

Comments (describe good or bad experience): _____

ROOM	very poor	poor	fair	good	very good
1. Pleasantness of room decor	O	O	O	O	O
2. Room cleanliness	O	O	O	O	O
3. Courtesy of the person who cleaned your room	O	O	O	O	O
4. Room temperature	O	O	O	O	O
5. How well things worked (TV, call button, lights, bed, etc.)	O	O	O	O	O

Comments (describe good or bad experience): _____

SAMPLE

Appendix B: Emory Press Ganey Sample Survey

MEALS	very poor 1	poor 2	fair 3	good 4	very good 5
1. Temperature of the food (cold foods cold, hot foods hot)	O	O	O	O	O
2. Quality of the food	O	O	O	O	O
3. Courtesy of the person who served your food	O	O	O	O	O

Comments (describe good or bad experience): _____

NURSES	very poor	poor	fair	good	very good
1. Friendliness/courtesy of the nurses	O	O	O	O	O
2. Promptness in responding to the call button	O	O	O	O	O
3. Nurses' attitude toward your requests	O	O	O	O	O
4. Amount of attention paid to your special or personal needs	O	O	O	O	O
5. How well the nurses kept you informed	O	O	O	O	O
6. Skill of the nurses	O	O	O	O	O
7. Skill of the person who started the IV (e.g., did it quickly, with minimal pain)	O	O	O	O	O
8. Courtesy of the person who started the IV	O	O	O	O	O

Comments (describe good or bad experience): _____

TESTS AND TREATMENTS	very poor	poor	fair	good	very good
1. Waiting time for tests or treatments	O	O	O	O	O
2. Explanations about what would happen during tests or treatments	O	O	O	O	O
3. Skill of the person who took your blood (e.g., did it quickly, with minimal pain)	O	O	O	O	O
4. Courtesy of the person who took your blood	O	O	O	O	O

Comments (describe good or bad experience): _____

VISITORS AND FAMILY	very poor	poor	fair	good	very good
1. Accommodations and comfort for visitors	O	O	O	O	O
2. Staff attitude toward your visitors	O	O	O	O	O

Comments (describe good or bad experience): _____

PHYSICIAN	very poor	poor	fair	good	very good
1. Time physician spent with you	O	O	O	O	O
2. Physician's concern for your questions and worries	O	O	O	O	O
3. How well physician kept you informed	O	O	O	O	O
4. Friendliness/courtesy of physician	O	O	O	O	O
5. Skill of physician	O	O	O	O	O

Comments (describe good or bad experience): _____

DISCHARGE	very poor	poor	fair	good	very good
1. Extent to which you felt ready to be discharged	O	O	O	O	O
2. Speed of discharge process after you were told you could go home	O	O	O	O	O
3. Instructions given about how to care for yourself at home	O	O	O	O	O

Comments (describe good or bad experience): _____

continued...

274859

PERSONAL ISSUES	very poor 1	poor 2	fair 3	good 4	very good 5
1. Staff concern for your privacy	O	O	O	O	O
2. How well your pain was controlled	O	O	O	O	O
3. Degree to which hospital staff addressed your emotional needs	O	O	O	O	O
4. Response to concerns/complaints made during your stay	O	O	O	O	O
5. Staff effort to include you in decisions about your treatment	O	O	O	O	O
6. Extent to which staff wore identification badges	O	O	O	O	O
7. Noise level in and around room	O	O	O	O	O
8. Upon entering your room, the extent to which all staff cleaned their hands (washed/sanitized their hands)	O	O	O	O	O

Comments (describe good or bad experience): _____

OVERALL ASSESSMENT	very poor	poor	fair	good	very good
1. How well staff worked together to care for you	O	O	O	O	O
2. Likelihood of your recommending this hospital to others	O	O	O	O	O
3. Overall rating of care given at hospital	O	O	O	O	O

Comments (describe good or bad experience): _____

Using any number from 1 to 10, where 1 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?

Worst Possible									Best Possible
1	2	3	4	5	6	7	8	9	10
O	O	O	O	O	O	O	O	O	O

EMORY HEALTHCARE COMMENTS

We appreciate you taking the time to provide us feedback on your Inpatient visit. We are working to improve services throughout Emory Healthcare. Please feel free to comment on any other experiences you have had with Emory Healthcare.

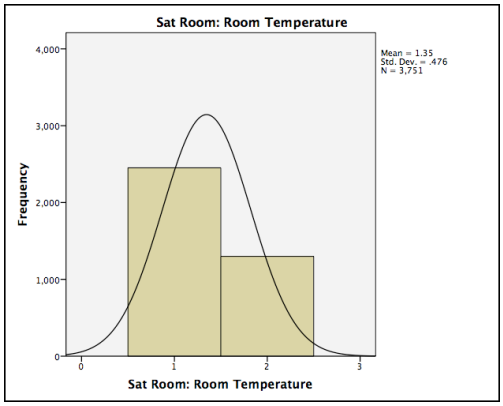
Patient's Name: _____ (optional) Telephone Number: _____ (optional)

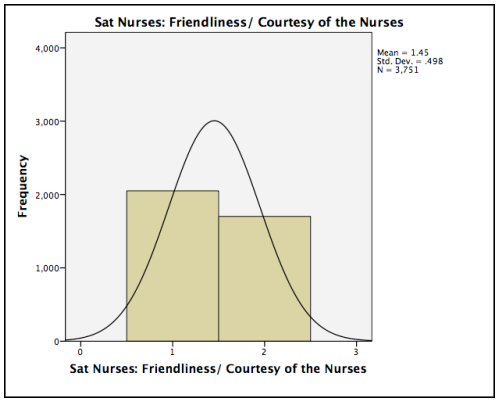
THANK YOU. Please return the completed survey in the postage-paid envelope.

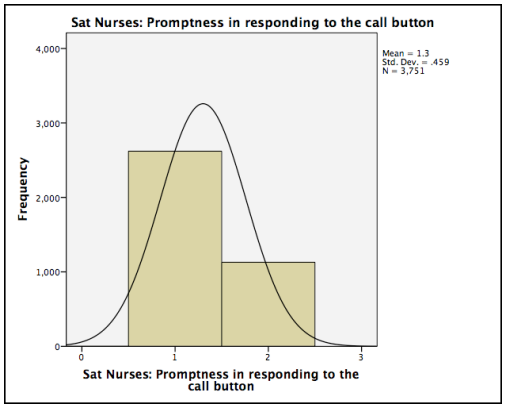
123456789

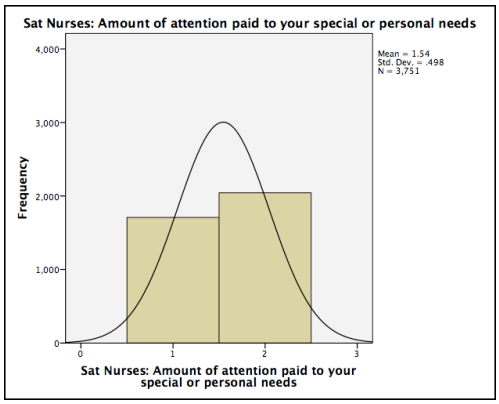
Appendix C: Preliminary Population- Variable Distribution Graphs

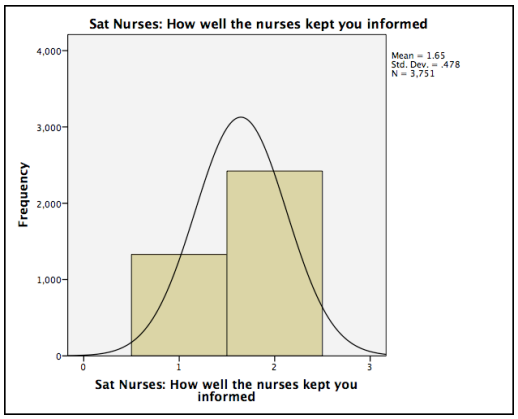
Survey top box distribution

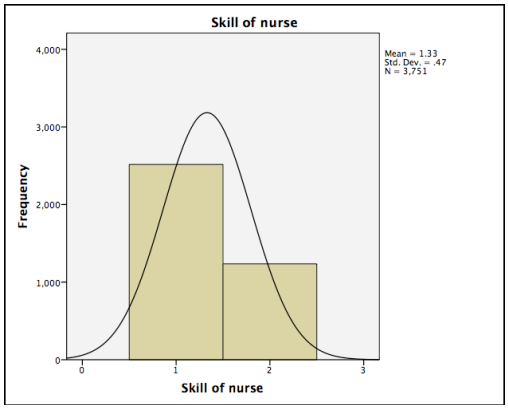




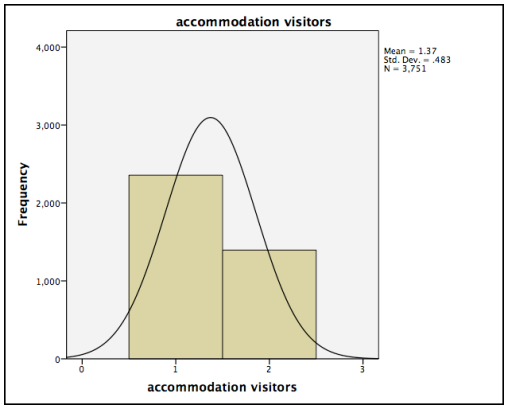


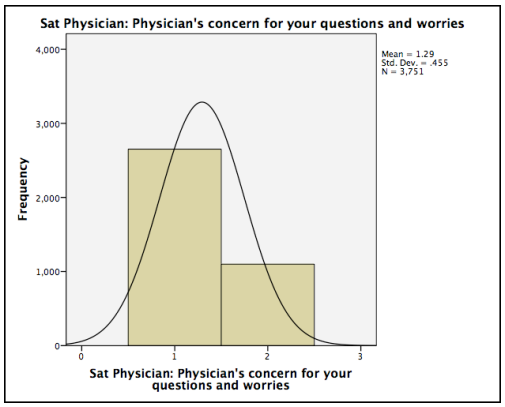


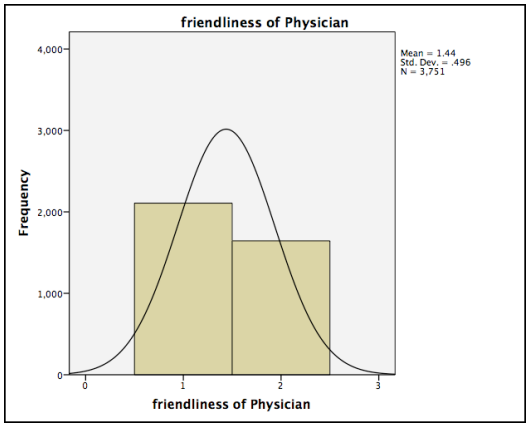


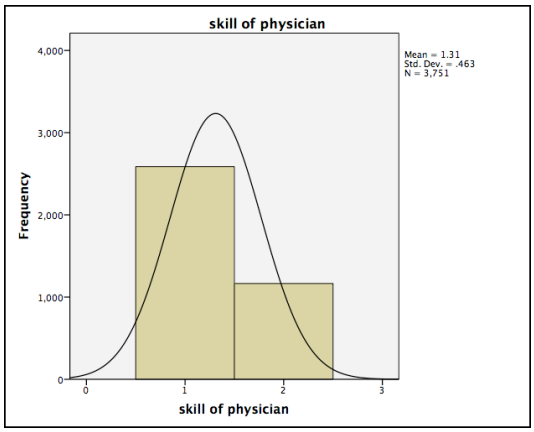


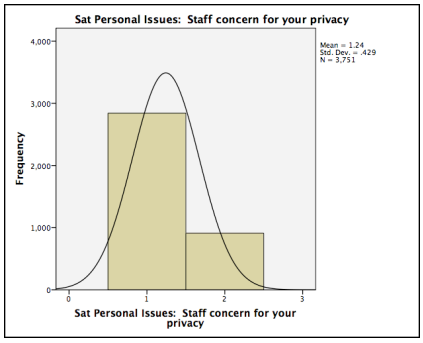
Appendix C: Preliminary Population- Variable Distribution Graphs Continued
Survey top box distribution

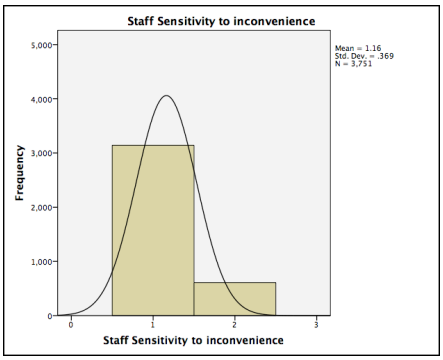




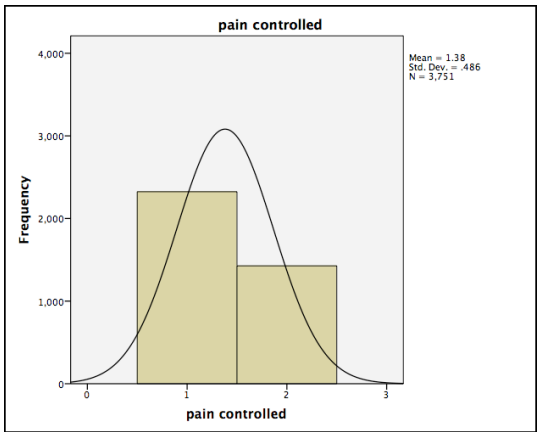


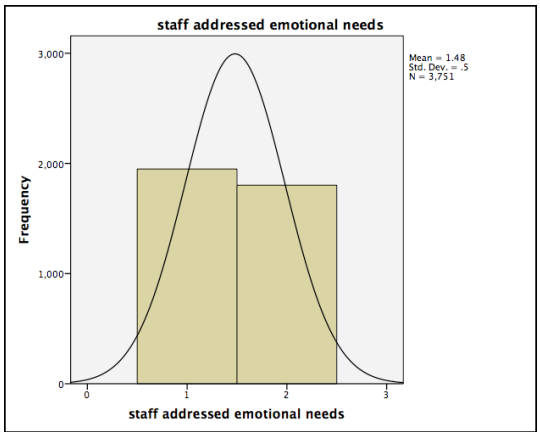




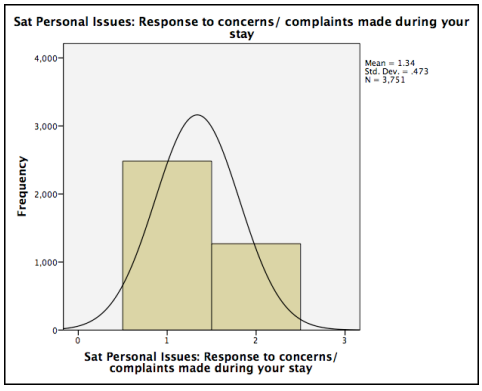


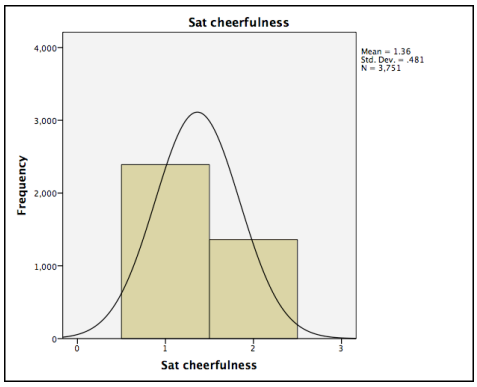
Appendix C: Preliminary Population- Variable Distribution Graphs Continued

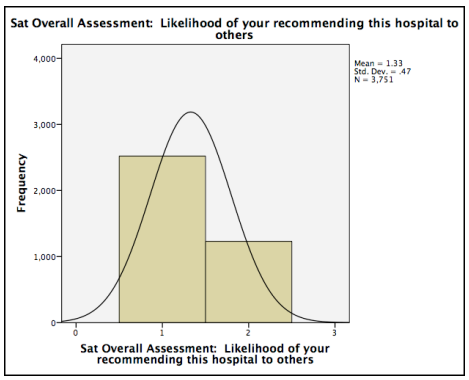




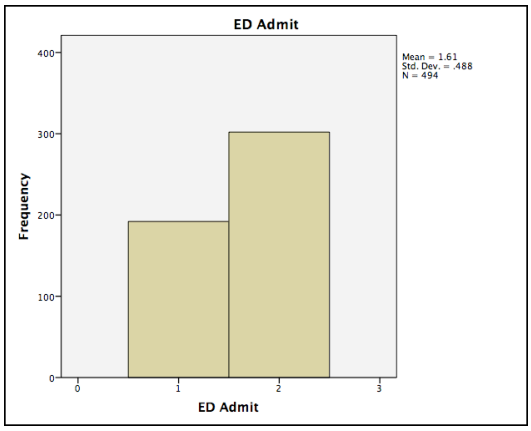
Survey top box distribution

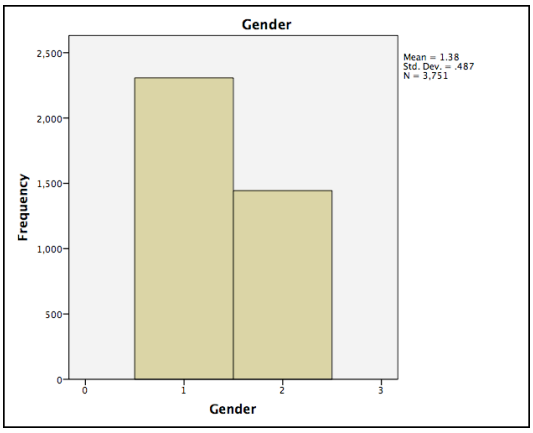


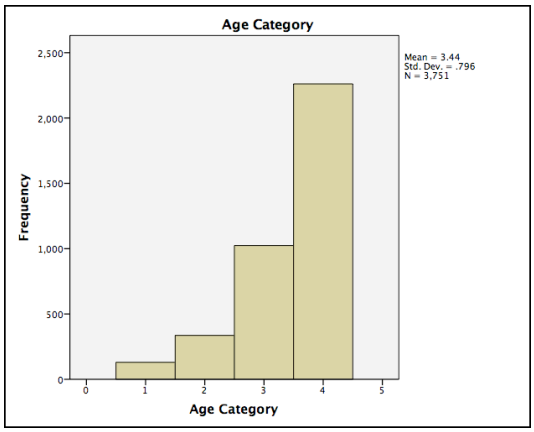




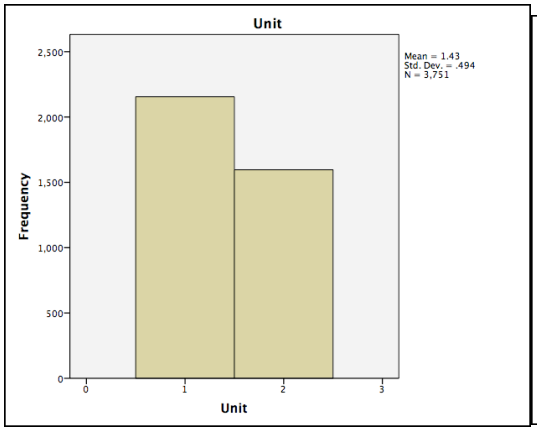
Appendix C: Preliminary Population- Variable Distribution Graphs Continued
Patient Characteristics

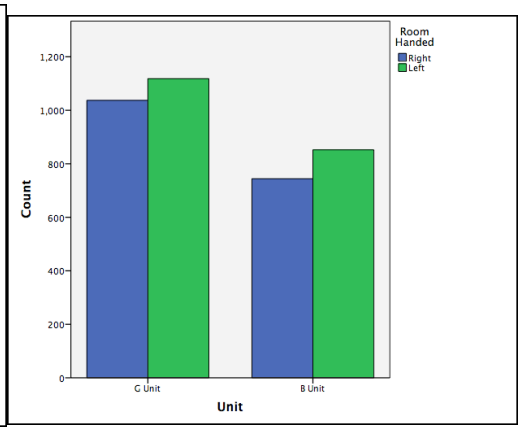




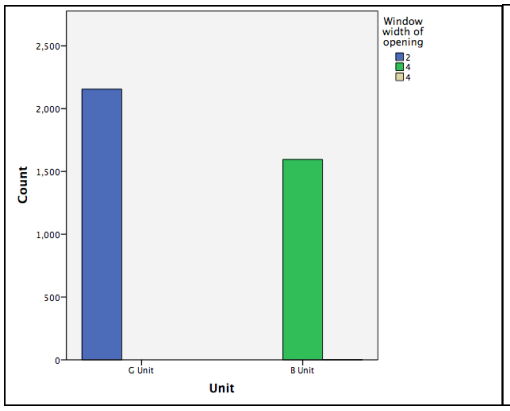


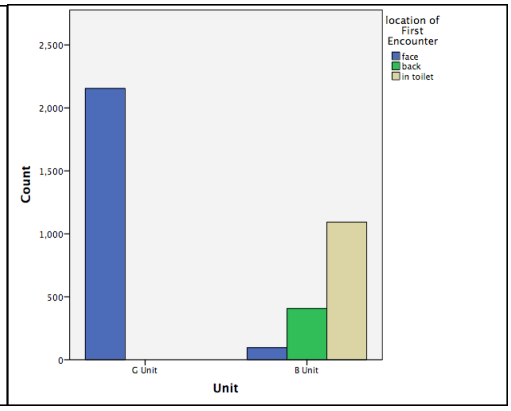
Appendix C: Preliminary Population- Variable Distribution Graphs Continued
Spatial variables distribution by unit

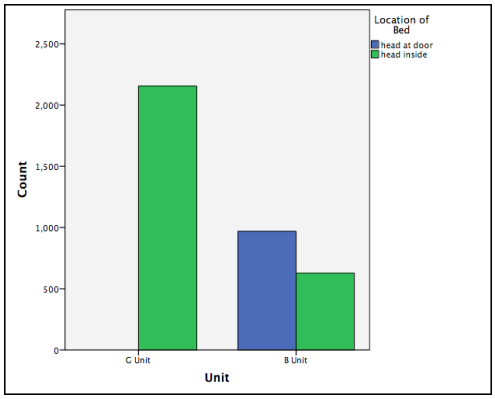




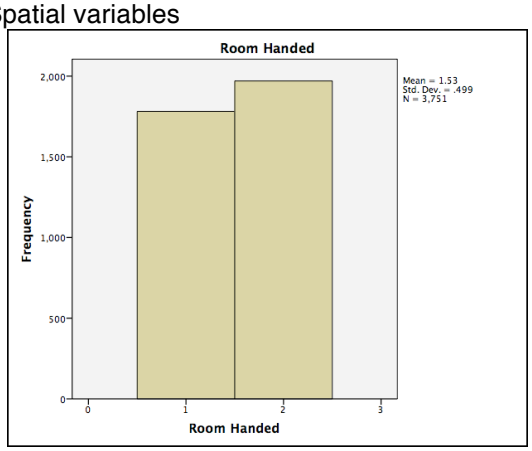
Appendix C: Preliminary Population- Variable Distribution Graphs Continued
Spatial variables distribution by unit

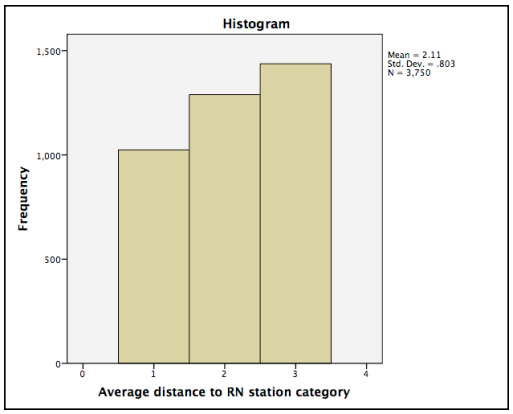


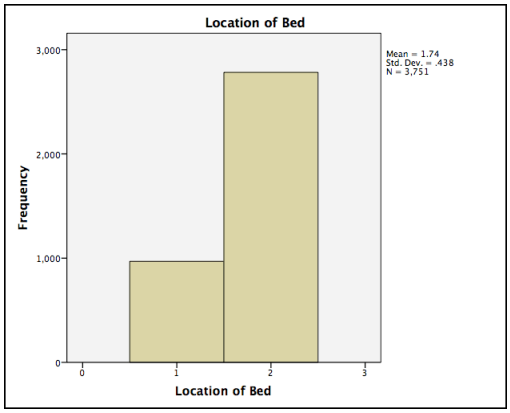


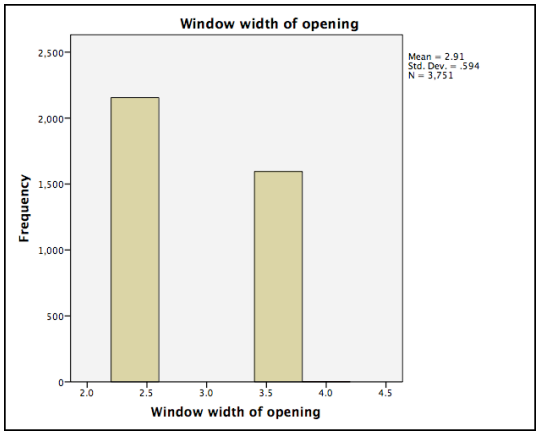


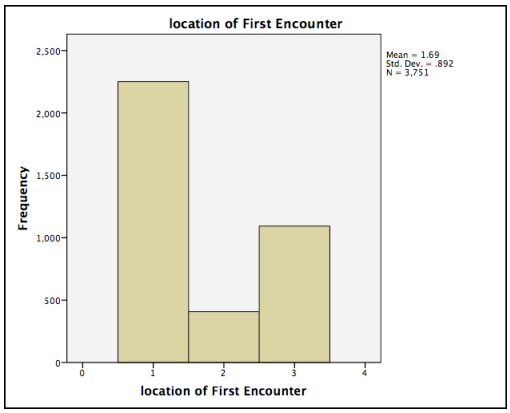
Appendix C: Preliminary Population- Variable Distribution Graphs Continued
Spatial variables





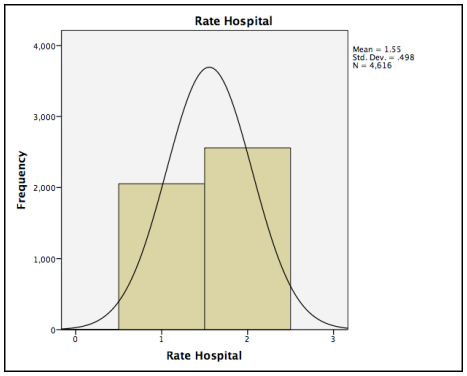


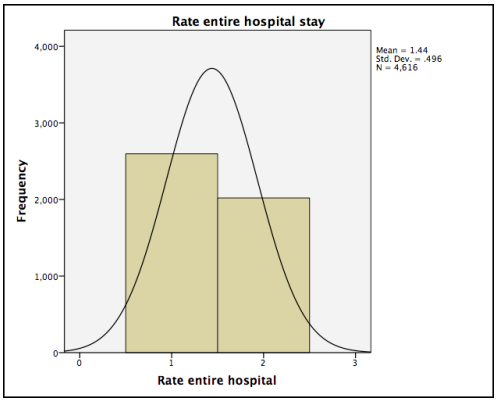


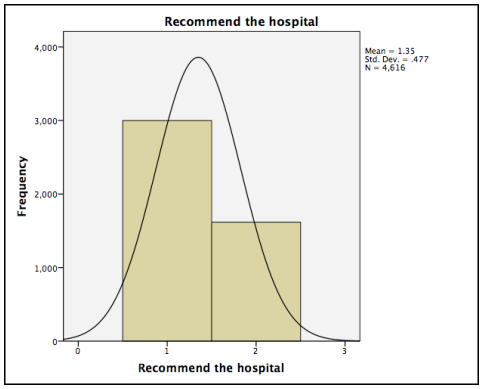


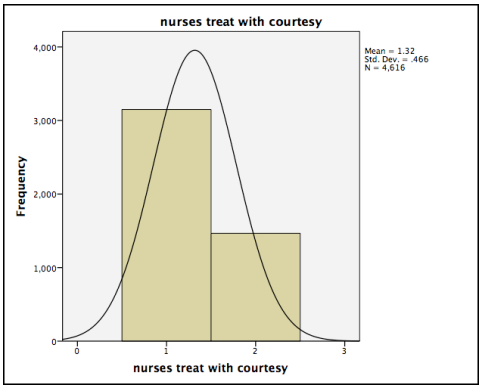
Appendix D: General Population-Variable Distribution Graphs

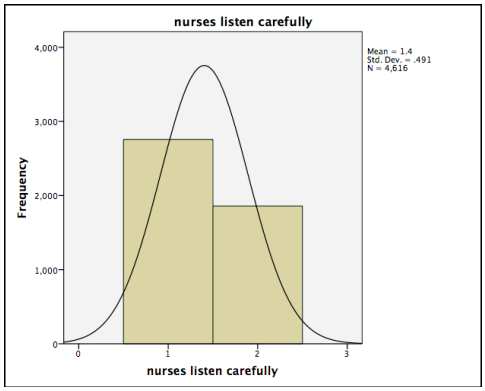
Survey top box distribution

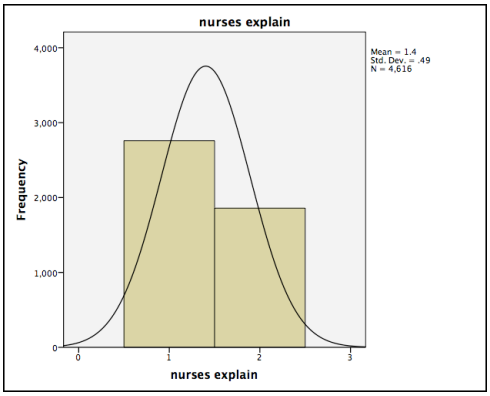




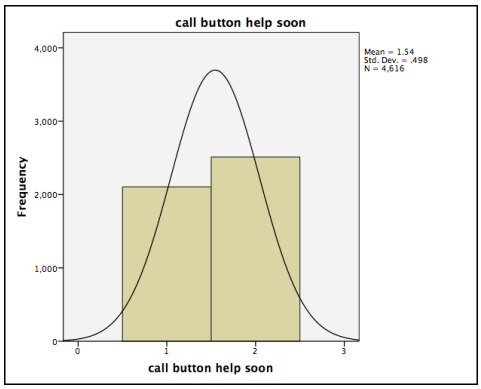


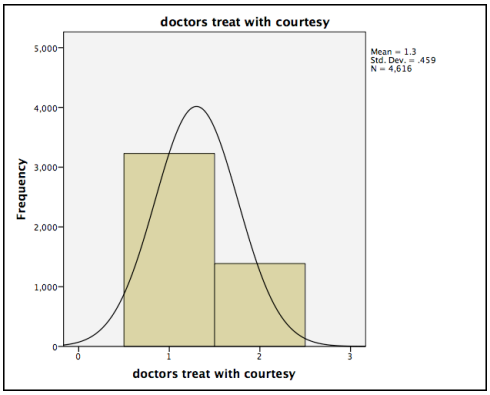




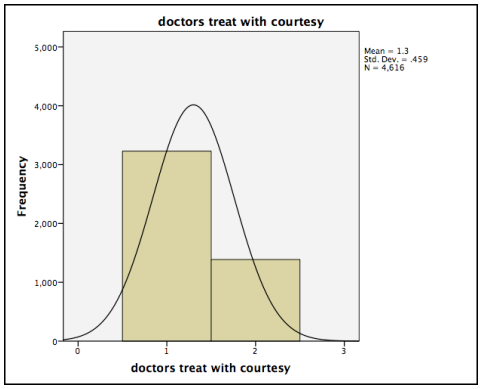


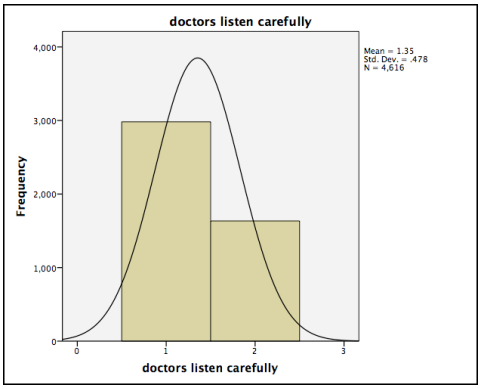
Appendix D: General Population-Variable Distribution Graphs Continued
Survey top box distribution

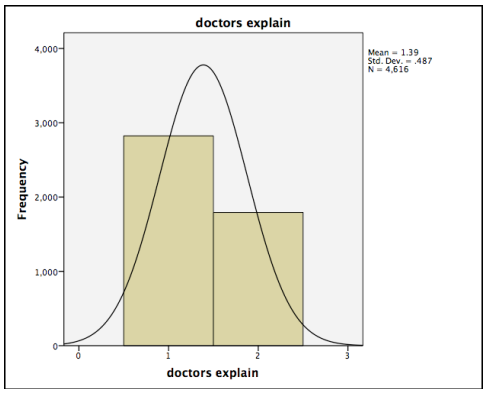


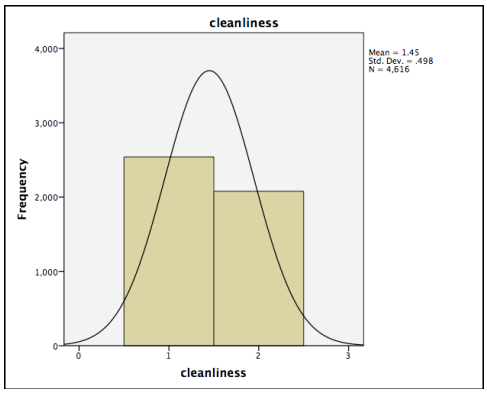


Survey top box distribution

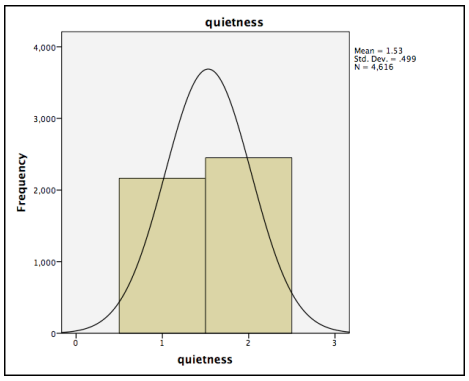


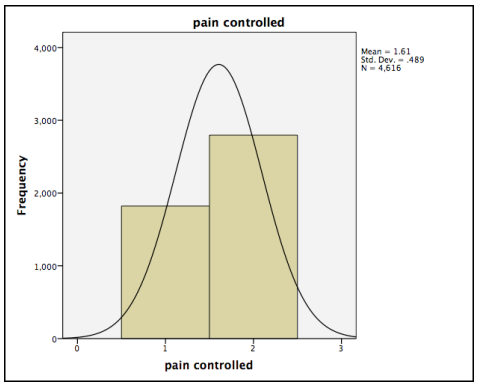


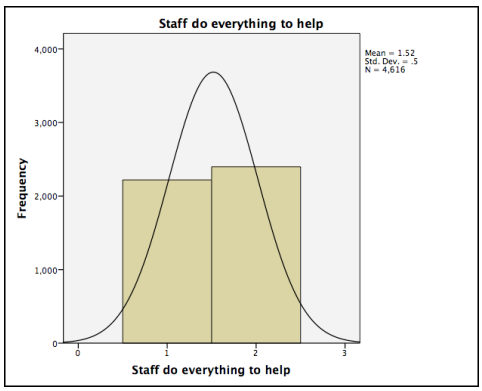


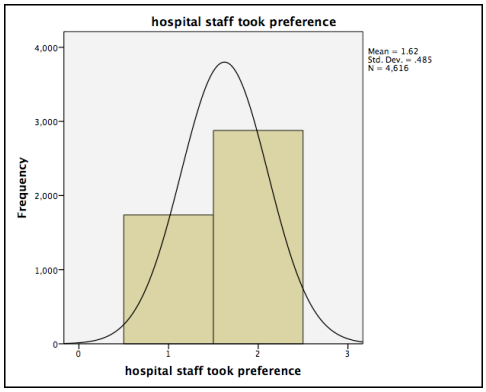


Appendix D: General Population-Variable Distribution Graphs continued
Survey top box distribution

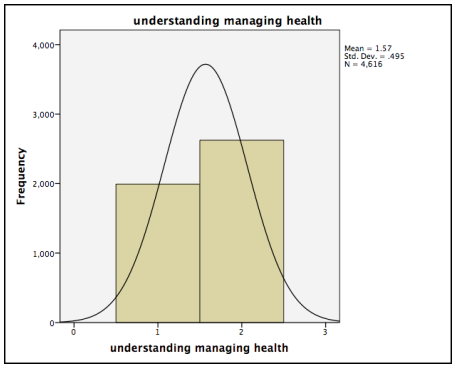


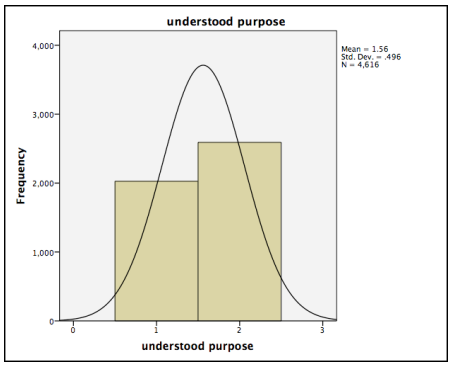




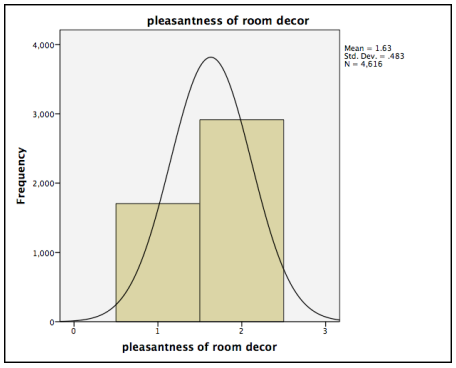


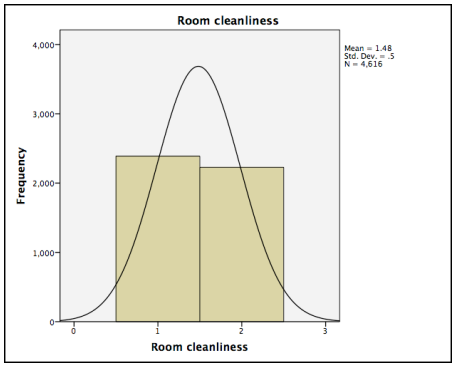
Survey top box distribution

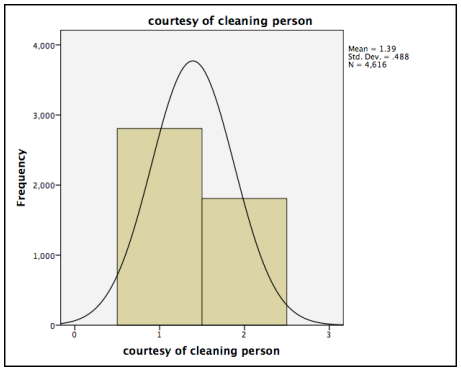


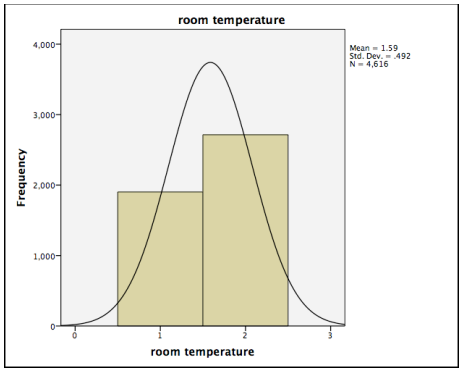


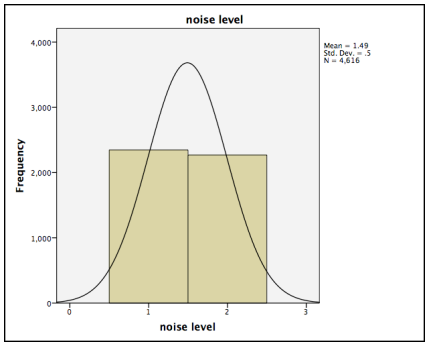
Appendix D: General Population-Variable Distribution Graphs Continued
Survey top box distribution

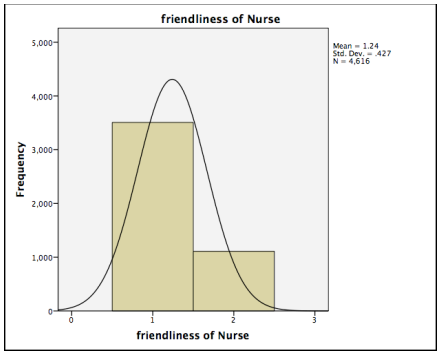




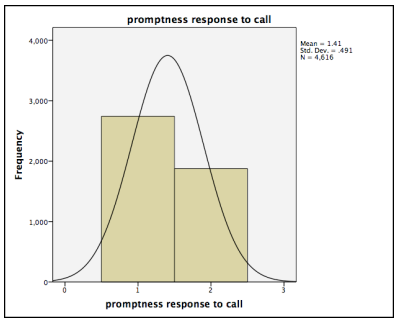


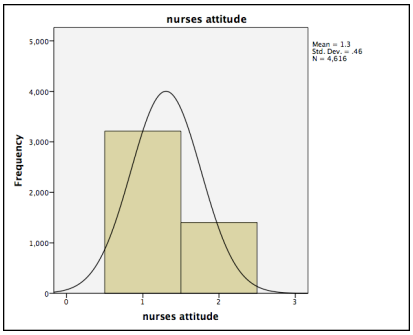


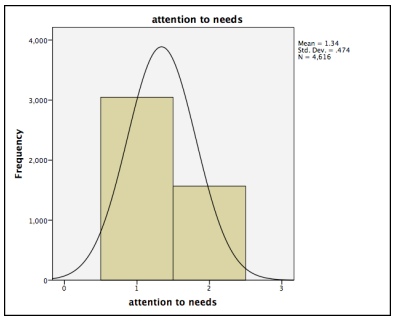


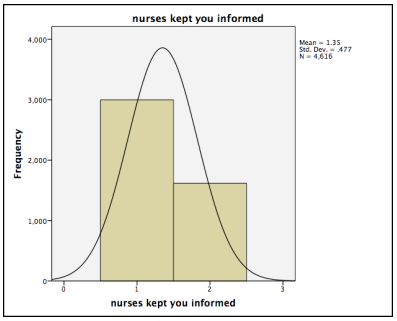


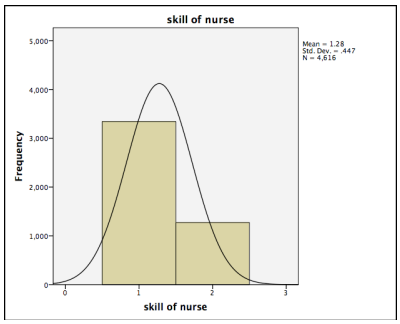
Appendix D: General Population-Variable Distribution Graphs Continued
Survey top box distribution

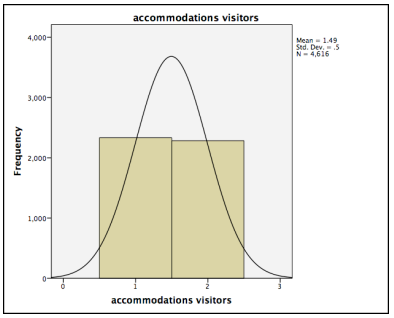


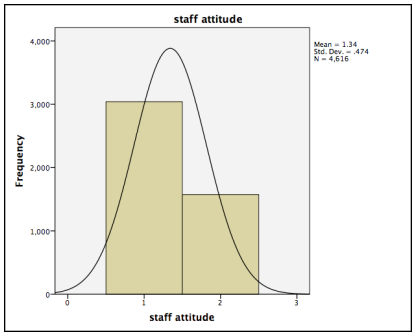


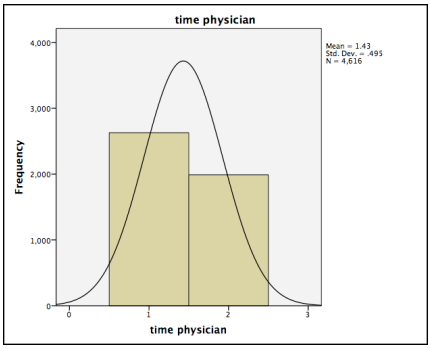




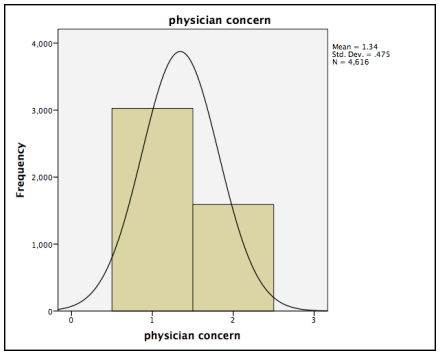


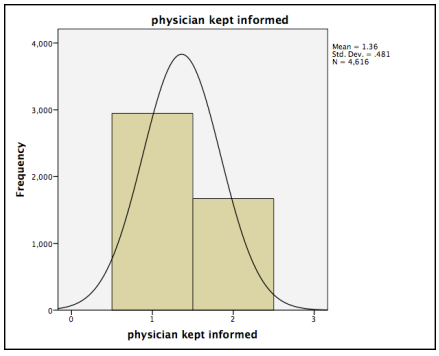


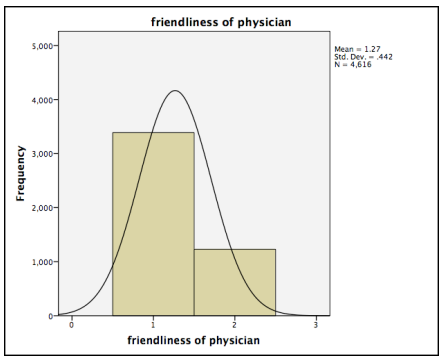


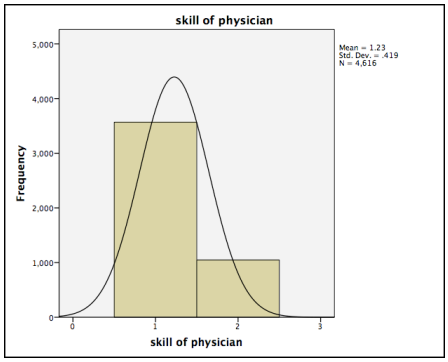


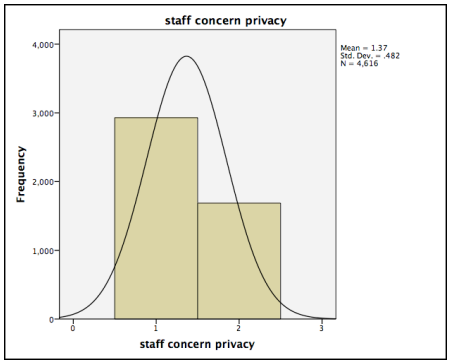
Appendix D: General Population-Variable Distribution Graphs Continued
Survey top box distribution

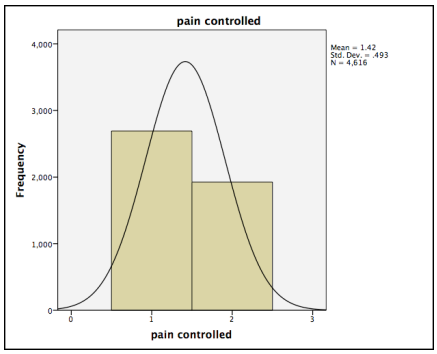


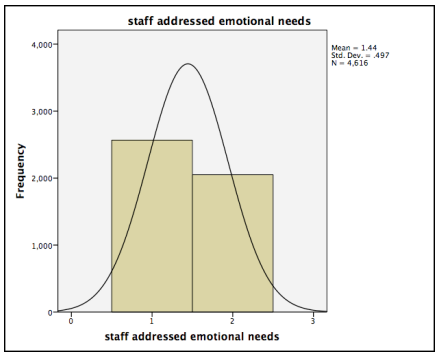


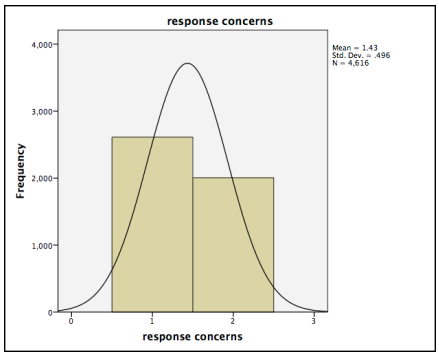




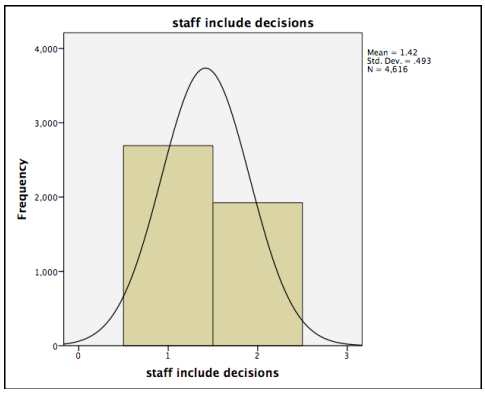


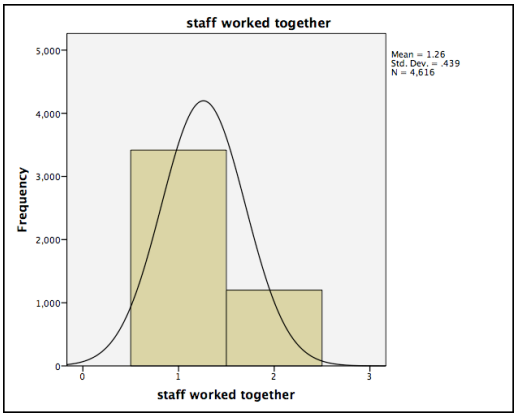


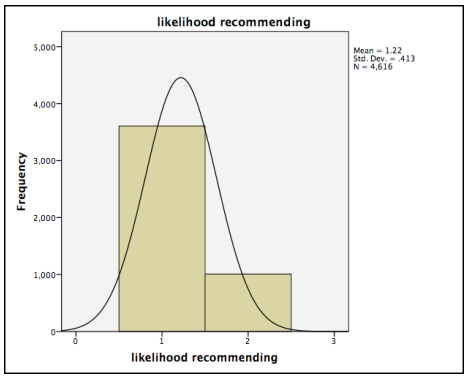


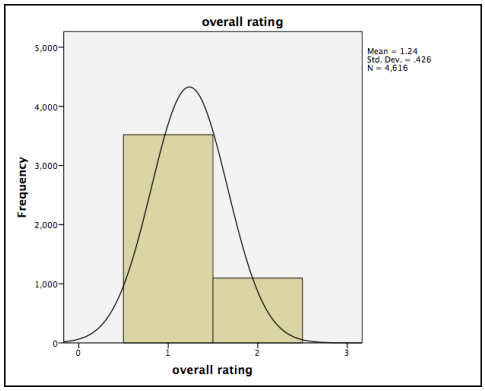


Appendix D: General Population-Variable Distribution Graphs Continued
Survey top box distribution

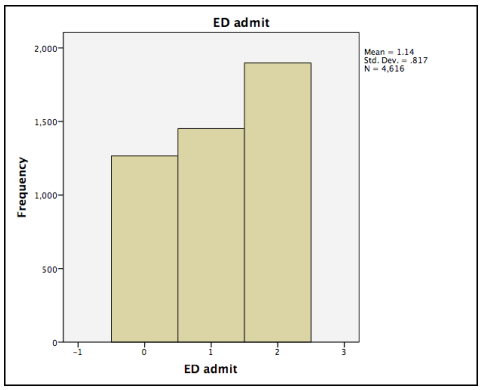


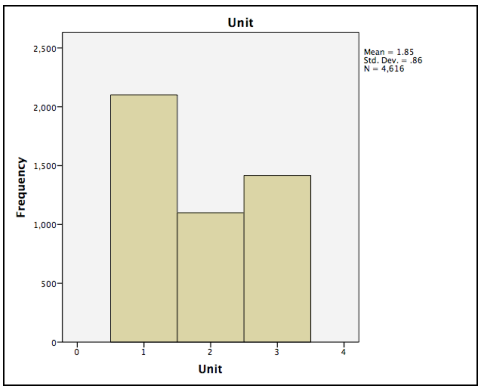




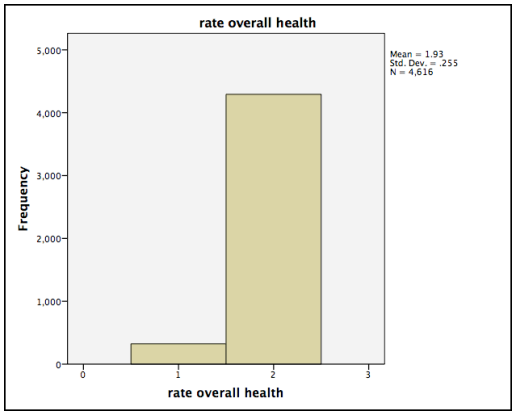


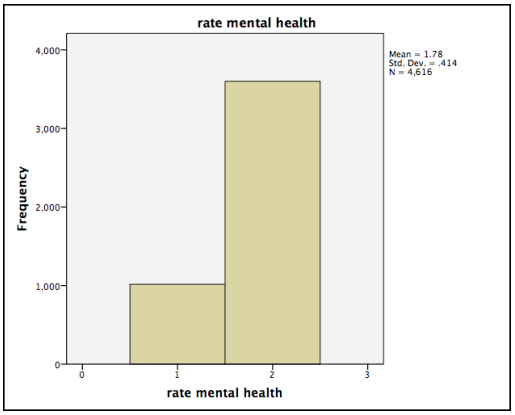
Patient Characteristics



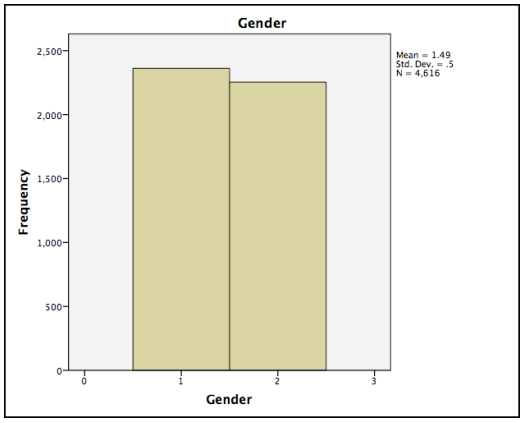


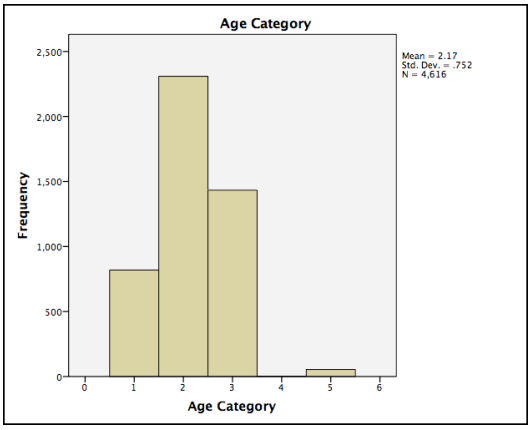
Appendix D: General Population-Variable Distribution Graphs Continued
Patient Characteristics



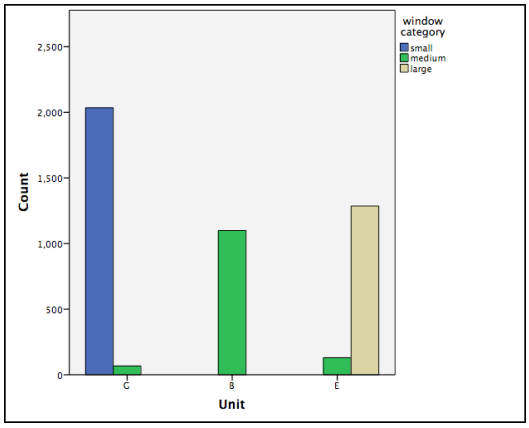


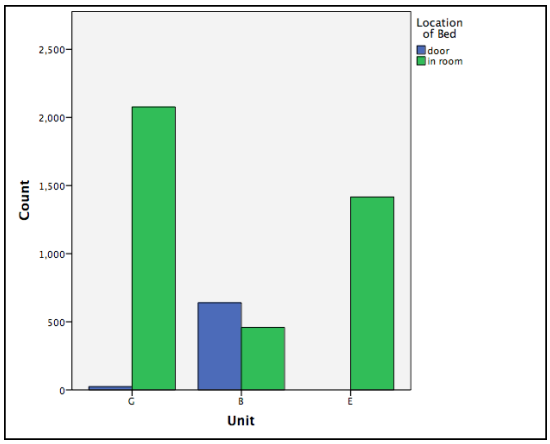
Patient Characteristics

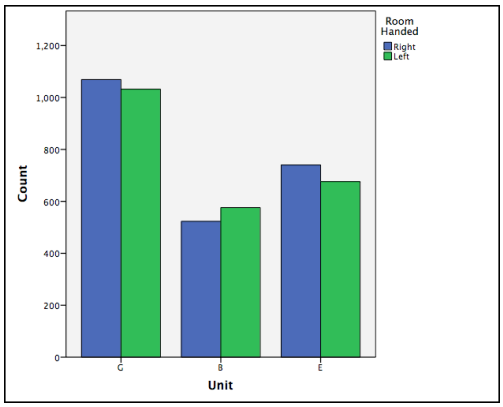


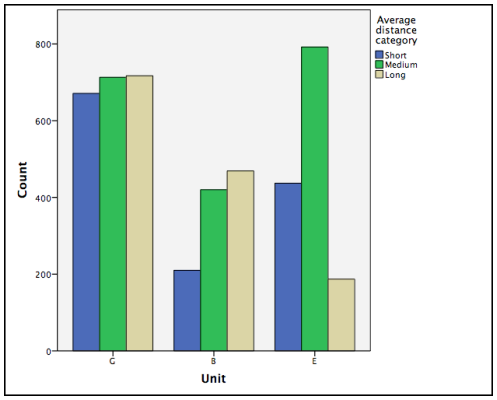


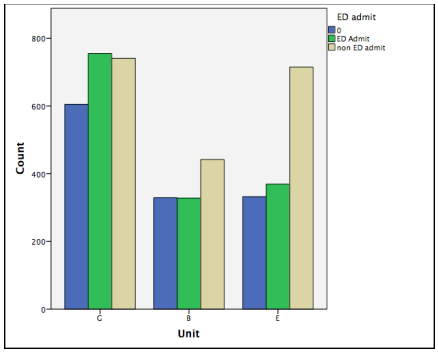
Appendix D: General Population-Variable Distribution Graphs Continued
Spatial variables distribution by unit

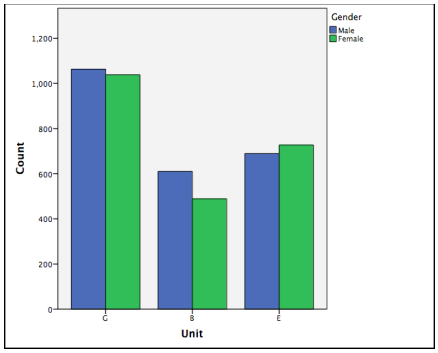




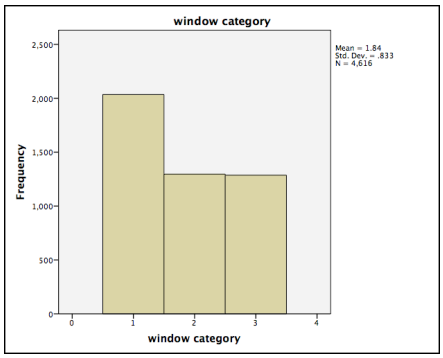


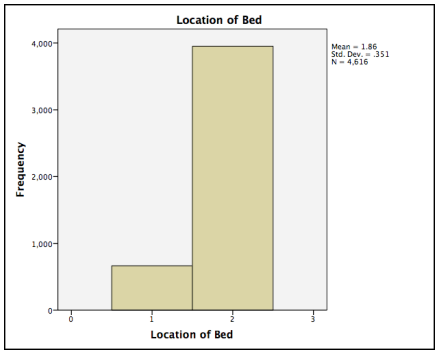


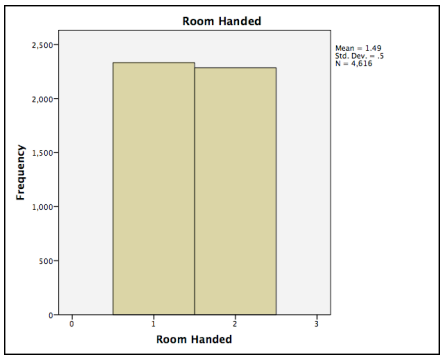


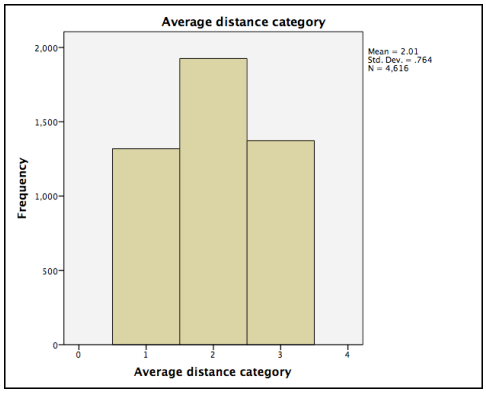


Appendix D: General Population-Variable Distribution Graphs Continued
Spatial variables









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Vita

Lorissa MacAllister

Lorissa MacAllister AIA, NCARB, LEED AP, EDAC, has a BSW in medical social work from the University of Vermont and a MArch in Architecture from the University of Michigan and is currently pursuing a doctorate in Architecture with a concentration in Evidence Based Design at Georgia Tech. For the past fifteen years, she has integrated her healthcare and architectural expertise to provide a unique design approach in the industry.

Lorissa has had a leadership role in creating sustainable, green guidelines globally for healthcare in co-chairing the Operations Section Pilot Review and as a foundational member of the Green Guide for Healthcare, which was used as the basis to create what is known as LEED for Healthcare. Leading transformative change for health facilities has been her focus, speaking nationally to help bring change that benefits occupants, community, and the environment while being sustainable to their operations. Lorissa has sat on sustainable design juries for the AIA and the Center for Health Design.

She was named AIA Young Architect of the Year for Grand Rapids in 2011 and for the State of Michigan in 2012. She also recently received the University of Michigan Alumni Council Athena Award in 2014.

Lorissa is the founder of Enviah, a research based consulting business using leading edge techniques to create healthy environments that support sustainable business operations and the movement of people.

Lorissa is also a senior research fellow and healing spaces specialist at the Samueli Institute, a not for profit research organization exploring the science of healing. She has worked on various research and consulting project to further define how the built environment can enhance healing through research.